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Advances in E-tendering Process of Government Construction Work (May 2020)

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ABSTRACT: Indian construction industry has played very important role in the process of economic transformation and advancement for over five decades and is the primary input for the socio-economic development of the country. Increasing complexity in design and competition of numerous stakeholders in modern construction projects are huge challenge for both clients and contractors to meet criterion of skills and capabilities required to successfully deliver a project at bidding stage. Implementation of advanced new E-tender process will increase the opportunity for bid documentation and as well free development of technology. Most of the contractor and companies are expert in engineering and technology. For documentation of government tender there will be many kinds of discussion and implementation of latest techniques accordingly to the growth of knowledge among the contractor, employees and owner for revising each and every aspect of work to be done by accepting new E-tendering terms without loss. While filling any government E-tender, contractors or company should be carefully understand new terminology or any new terms and condition or any new contract clause to avoid rejection in technical bid. After fulfilling technical criteria, major decision to bid is a financial decision because of two reasons. First, the contractor assumes substantial costs for the preparation of estimate and tender at risk of not recovering them if he is not awarded the tender. Second, and most importantly, the contractor commits himself for performing allotted work as per his quoted amount. So he should take care to get sufficient profit with quality for work. To improve or develop the contractor or company to withstand the competitors in the market, they must have to always familiar with new clauses include in bidding process. An accurate decision is to be taken than only the bid may give some kind of satisfaction with low and admirable cost estimate.

INDEX TERMS: contractor, companies, advanced, E-tender, government, clause, contract new terminology, decision

1. INTRODUCTION

After getting Administrative approval, Technical sanction and budget approval of any work its tender is prepared and invite for interested contractor to carry out execution of work. Experienced and technically sound contractor willing to do work, will fill this tender and quote amount of tender at reasonable rate. After opening of tender by government department or concern authority, tender will be awarded to lowest amount quoted contractor, and he is ready to execute work as per terms and conditions, mentioned in tender.

1.1 Tender Meaning:

Tender is defined as offer in writing for execution of certain specified work or for supply of specific materials subject to certain terms and conditions such as rates, time limit etc.

Contractor is supposing to study plans, specification of work to be executed, term & condition etc mentioned in tender; before filling, quoting and submitting tender.

The process of bidding for work or contracts. Government seek the best price or value for money from a selection of prospective contractor. The whole process is done by competitive tendering.

1.1.2 General about E-Tender process:

In Maharashtra before year 2009, whole process of tendering was done manually. (i.e. the process which is explained in this chapter is manually process of tendering). In the year 2010, the state Government started the e-tendering process after receiving flak for corruption and many fraud cases against manual tendering process.

Now onwards, Maharashtra Government make e-tendering mandatory for project over Rs. 3 lakhs.

Following the aims and objectives for nature of tendering:

➢ Provide an environment that encourages interest and competitive offers from well qualified and experienced construction contractors.
➢ Obtain a fair and best quotation rate for undertaking process of construction works.
➢ Obtain a clear understanding of rights and obligations of all parties.
➢ Allow resolution for general issues requiring clarification to all tenders.
➢ Understand new terminology comes in recent tendering process.
2. LITERATURE REVIEW

2.1 Edwin H. Chan, Maria C. Au:
This states that the risk for a contractor in sudden increase of material rates as per not given with the risk transfer. Therefore, understanding the factors influencing the contractors pricing of contract risk is crucial for employers to optimize the cost effectiveness of risk allocation in contracts. The features that contractors recognize to be dominant when they are pricing time related contract risk.

2.2 Aftab Hameed Menon, Ismail Abdul Rahman:
In Malaysian, traditional lump sum system, design and build/turnkey system says that the typical contractual relationship under traditional method in order to take the relation between client with contractor & consultant, and contractor with sub-contractor & supplier. Typical sequence of operations like brief, design, tender, construction. Management procurement: client with main contractor & consultant and by the same time with workers. Operations of management procurement brief, design, construction.

2.3 Md Imran Khan, Maneeth P D, Brij Bhusan S:
Its gives the information on the procedures adopted for recording, reporting & collecting information related to the performance of project by the use of DPR and MPR to estimate the progress stage of the project which have to be cross checked by the pre-bid scheduling if any lagging of plan should be taken to the view of that engineer to give the corresponding reason and explanation for the delay of work.

2.4 Unmesh. Y. Polekar, Rohit. R. Salgude:
It consists of proper planning and scheduling is most efficient part in completion of project without time lagging and knowing in glance for the material required. And regular monitoring of the project will give satisfactory work for the workers and engineers working in that project. Mainly the planning office should know about the conditions corresponding to the respective manner by using some kind of software techniques.

2.5 Vladimir Obradovic, Petar Jovanovic:
The implementation of these research are important to both project managers who wish to improve their performance and successes rate and organization in their human resource policy. There is a very high positive correlation between emotional intelligence and professional success. For recruiting staff to the position of project managers should consider the concept of emotional intelligence. But not only for the project managers it also revealed to decide on human resource development program.

3. E-TENDERING PROCESS
Basically before year 2009 all tendering process done manually. In E-tendering whole process is done online like:

1. Online Submission or attaching of all scan document by contractor
2. Tender fees and EMD online payment.
3. Rate quotation in financial bid is also done online.
4. At last after tender is opened, comparative statement is also shown online.

But mainly for neutralizing fraud of leakage of quoted amount, E-tender is taken into act for contractor selection process. Also for following various reason E-tendering take place of manual tendering process.

### Table I
Difference between Manual and E-tendering Process

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<td>Long procurement cycle</td>
<td>Short procurement cycle</td>
<td></td>
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<td>2.</td>
<td>Expensive</td>
<td>Economical-fixed cost</td>
<td></td>
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<td>3.</td>
<td>Paper based procurement</td>
<td>Environmentally friendly</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Restricted mobility</td>
<td>Any time-anywhere bidding</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>No work on holidays</td>
<td>Bidding possible on holidays</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Prone to human error</td>
<td>Automated and accurate process</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Content not sharable</td>
<td>Sharable content</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Wastage of space to store bid</td>
<td>Lifelong storage on Internet / CD / PC</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>More chances of fraud w.r.t. quotation of rate</td>
<td>No chances of fraud w.r.t. quotation of rate.</td>
<td></td>
</tr>
</tbody>
</table>

3.1 Data or tools required for E-tendering process:
Data or tools required for E-tendering process:

1. Following list of scanned copy of technical document required during submission of technical envelope:
   - Forwarding letter,
   - Declaration letter
   - Registration of pan card
   - Pan card & last three year ITR
   - GST Certificate
   - Professional tax registration
   - Form no. 1 to 5
   - Machine purchase/ rent agreement
   - Degree certificate of employees appointed
   - Work done certificates
   - Affidavit / Notary if mentioned

2. Online payment mode option like net banking / debit card:
Tender fees and EMD amount required to pay by contractor using either net banking or debit card. Many times it’s mandatory to contractor that payment should done through its own account.

(3) Computer / Laptop:
System of computer and laptop should be updated since all tender submission done through online using Computer / Laptop.

(4) Specific version of browser with updated java:
Tender filling can be done smoothly by Internet explorer browser with update Java version.

(5) MS office:
Computer or laptop should be ready with installed MS office, since BOQ in form of excel is edited using MS office only.

(6) Digital Key:
Digital key is must while submitting online tender, without digital key no can submit E-tender. Digital key available with class II & class III of many brand like E-token, E-mudra, E-pass, Aladin, Starkey etc.

3.2 E-tendering Procedure:
Whole tendering process, right from sanctioning of work to selection of contractor is explained as below:

![Figure 1. Flow chart of Tender process](image)

(A) Approval of work from Government Authority

(B) Prepare tender draft containing detailed specification, BOQ, contract document by concerned government department

(C) Invitation of tender by concerned government department

(D) Submission of tender by contractor

(E) Opening of Tender by concerned government authority

(F) Scrutiny of tender by concerned government authority

(G) Comparative statement and award of contract by concerned government authority.

(H) Work order to (awarded) selected contractor

Table II Comparative Statement of tender

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of Contractor</th>
<th>Tender Amount Quoted (Rs)</th>
<th>Remark</th>
</tr>
</thead>
</table>

<table>
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<tr>
<th>Tender estimated cost = Rs. 75,00,000</th>
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</table>

Following points should be checked carefully:

(i) Check that each tender is signed by contractor and has contain his address.

(ii) There should be no additions, or alterations or deletions in terms & conditions included in tender submitted by contractor.

(iii) Verify that rates against each item are written in figures as well as words. Multiplication of quantity of each item and its corresponding rate should also be verified.

(iv) Check over writing, omission in any item rate in tender.

(v) If rate quoted by contractor is not clear, doubtful or far below, then tender may consider as invalid.

(vi) Officer should check all technical documents of contractor and also verify financial stability of contractor.

(vii) After scrutinising all documents, officer prepare open Financial envelope 2.

(G) Comparative statement is generated automatically after online opening of tender by [tender estimated cost = Rs. 75,00,000] /-
1. A  71,00,000 /- (Lowest) L1
2. B  72,50,000 /-
3. C  73,00,000 /-
4. D  74,00,000 /-
5. E  75,10,000 /- Highest

Tender will be awarded to contractor, who quote the lowest amount.

(H) Awarded contractor need to submit security deposit to department office within 7days of opening of tender.

After that contractor will get work order to start the execution of work.

FIGURE 2 Tendering Preparation Process

Above process explain tender creation in government of Maharashtra for various department like PWD, ZP, WRD, MJP, PMC etc as per requirement. In which tender officer need to data from various department like architecture, structural engineer, quantity surveyor etc.

After collection data and setting term and condition of contract, adding BOQ etc. government tender officer of department prepare tender set to invite tender online by publishing tender on web site like:
https://mahatenders.gov.in/nicgep/app,
https://mahatenders.gov.in/nicgep/app.

FIGURE 3 E-tendering submission Process

Above explain whole online E-tender filling process. In which various interested contractor filled online tender through computer or laptop by inserting digital key.

Whole process of submission and online tender fess and EMD payment should be done before last date of submission. On tender opening date government officer open tender.

First he scrutinised all scanned technical document, after that open financial envelop of qualified contractor only. Last he displayed comparative statement on e-tender web site. At each time contractor get sms and email on his register number and email id, which notifying each stage of tender opening.

Table III

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Process</th>
<th>Govt. Department stage</th>
<th>Vendor stage</th>
<th>Date &amp; time</th>
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<tbody>
<tr>
<td>1</td>
<td>Publish Tender online</td>
<td>Tender Release</td>
<td>-</td>
<td>Date:24/5/2020 At 10:00 am</td>
</tr>
<tr>
<td>2</td>
<td>Download Period of bid</td>
<td>-</td>
<td>By Contractor</td>
<td>Date:24/5/2020 At 10:00 am</td>
</tr>
<tr>
<td>3</td>
<td>Pre-bid</td>
<td>At govt.</td>
<td>-</td>
<td>Date:</td>
</tr>
</tbody>
</table>
### 3.3 New terms in E-tendering:

Before filling tender contractor or company need to study various term introduced recently in tender set. As per this new term contractor should prepared document and submit it to avoid rejection of tender either in technical or financial envelope.

Following are some explanation of new terminology introduced recently in tender process of government.

#### A. Additional Performance Security:

If contractor quote tender with in below amount he has to pay additional performance security deposit in term of DD apart from earnest money deposit and security deposit.

**Demand Draft of any Nationalised/Scheduled Bank for Additional Performance Security Deposit for Quoting Offer**


Following was contractor has pay DD:

- **A.** If the Bidder intends to quote his offer below more than 1% upto 10% of the estimated cost put to Bid then he should submit a Demand Draft of any Nationalised/Scheduled Bank amounting to 1% of the Bid cost of the department towards Additional Performance Security.

- **B.** If the Bidder intends to quote his offer more than 10% below the estimated cost put to Bid then he should submit Additional Performance security 1% for every percent after 10% below percentage in addition to the cost of 1% Additional Performance security mentioned above clause A for quoting below offer.

  (eg. If Bidder quotes his offer 15% below the estimated cost put to bid, then he should submit 15 - 10 = 5% Additional Performance security + 1% Additional Performance security = 6% amount of the cost put to bid as a total Additional Performance Security.)

- **C.** If the Bidder intends to quote his offer more than 15% below the estimated cost put to Bid then he should submit Additional Performance security 2% for every percent after 15% below percentage in addition to the cost of 1% Additional performance security mentioned above clause A and 5% Additional performance security mentioned above clause B for quoting below offer.

  (eg. If Bidder quotes his offer 19% below the estimated cost put to bid, then he should submit 19 - 15 = 4% x 2 = 8% Additional Performance security + 1% Additional Performance security as per Clause A and 5% Additional Performance security as per Clause B i.e. Total (1+5+8) =14% amount of the cost put to bid as a total Additional Performance Security.)

#### B. GST Clause:

Before quoting rate contractor should be familiar below mentioned GST clause:

The Rates Quoted by the Contractor shall be deemed to be inclusive of all taxes other than Goods and Service Tax 2017 that the contractor will have to pay for performance of this contract.

The rates quoted by the contractor shall be exclusive of Goods and Service Tax 2017 which shall be paid extra by the employer at prevailing rates. The employer will perform such duties in regard to the deduction of such taxes at sources as per applicable law.

#### C. Digitally signing the documents to be uploaded:

Many government department mandatory mentioned that each document should be digitally signed by contractor. Contractor has to follow rule to avoid rejection.

#### D. Rule while quoting tender by contractor:

The Tenderer should quote his offer duly signed in terms of percentage of estimated rates at the appropriate place of tender document to be submitted only in Envelope No.2. He should not quote his offer anywhere directly or indirectly in Envelope No.1. The contractor shall quote for the work as per details given in the main tender and also based on the detailed set of conditions issued / Additional stipulations made by the Department as informed to him by a letter from Chief Engineer / Superintending Engineer after Pre-Tender Conference. His tender shall be unconditional.

1) **Security deposit clause:**

The successful tenderer shall have to pay 50% initial security deposit in cash or in shape of National Saving Certificate or Fixed Deposit Receipt or Bank Guarantee pledged in favour of Executive Engineer, Public Works Division, Pune or Bank Guarantees from a Nationalised/Scheduled Banks in the enclosed form and complete the contract documents failing which his earnest money will be forfeited to Government. The balance 50% security deposit will be recovered from the R.A. bill at 1% of the bill amount. Amount of total Security Deposit to be paid shall be 2% of the cost of accepted tender or estimated cost put to tender whichever is higher.

Initial Security Deposit may be in Bank Guarantee Form in format of tender document for full period of completion of work and it should be extendable upto expiry of valid extension if any as directed by Engineer-in-charge.

2) **Decryption & Encryption:**

By using Decryption & Encryption keys contractor can able to Convert of numerical value in some coding or symbolical format. Which will helpful for avoiding leakage of amount quoted by contractor.

3) **Software’s currently used for ETenderin Process**

- Coupa Procurement by Coupa Software.
- E Bid e Xchange by e Bid Systems.
- Panacea by Panacea Software.
• Promena e-Sourcing by Promena e-Sourcing Solutions.
• Sourceit by sourceit.
• Bid Sync e Procurement by BidSync.
  1. Web Req by GT Management.
  2. Buyer Quest e PROCUREMENT by Buyer Quest.
  3. Procurement Software and e Invoicing by Xeeva.
  4. Basware Procurement by Basware.

4. CONCLUSIONS
The traditional systems of procurement in government departments through manual modes suffered from various problems such as inordinate delays in tender/order processing. Tendering systems should also include appropriate security mechanisms for increasing the system’s reliability which can be engulf by tendering process. From the deep study of the tendering and bidding process it may be concluded that private tender process is more accurate, time and cost saving over the traditional tender process. Political issues can be solved by adopting private tendering instead of traditional tendering.

E-tender process has number of advantages over traditional tendering process such as document save in soft copy and in safe in position, free from corruption and no chance to alter the quoted the rates, paper work reduced, bidding possible on Holidays and after office hours, automated and accurate. Privacy of rates and other important document is possible. Tender not necessary to submit by hand. If in case estimation cost of E tender having 3 lakhs amount which can be reduced up to 1 lakh then it will be possible to apply this method to overall system to eliminate the limitation to apply this method to any particular sector. In this help of process the change the tender and bidding process and used the technology they have the great change in the process.

ACKNOWLEDGMENT
It’s a genuine pleasure to express my thanks to my colleague, Prof. A.C.Shirle, Prof. S. R. Kate, Prof. A. A. Burade and Prof. J. S. Athalye, Trinity Academy of Engineering, Pune. Their timely, scholarly advice, meticulous scrutiny and scientific approach helped me to a very great extent to accomplish this task.
I would also thank my HOD Dr. S. S. Deshmukh and Principal Dr. N. J. Uke and Institution for unconditional support.

REFERENCES
Structural Engineering from the Shivaji University and Pune University in 2015 and 2018 respectively. Since 2017, She has been an Assistant Professor with the Civil Engineering Department, Trinity Academy of Engineering, Pune, India. Her research interests include Structural analysis, Pre-stressing, Fragil curves.

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Water Quality Analysis of Water Treatment Plant for Karnal Village, Maharashtra, India (May 2020)

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ABSTRACT Karnal is a village located in Sangli district has a total population of about 6000 in 2011. The village has a water treatment plant constructed in 2013. The prime objective of a water supply agency is to provide hygienically safe-water to its consumers. Further, it is necessary that the water required for the need should-not contain unwanted impurities, harmful chemical compound, and bacteria in it. Therefore it is extremely essential to purify the water before it is supplied to consumers. In the village treatment plant is available, its efficiency is checked and suggested suitable measures to maintain the quality. Also, further contamination during waster distribution has been also monitored.

INDEX TERMS Water quality analysis, Water treatment plant and Water quality monitoring.

1) INTRODUCTION

The raw water quality available in India varies significantly, resulting in modifications to the conventional water treatment scheme consisting of aeration, chemical coagulation, flocculation, sedimentation, filtration, and disinfection. The backwash water and sludge generation from water treatment plants are of environment concern in terms of disposal. (Kate and Kumbhar, 2017). Therefore, optimization of chemical dosing and filter runs carries importance to reduce the rejects from the water treatment plants. Also, there is a need to study the water treatment plants for their operational status and to explore the best feasible mechanism to ensure proper drinking water production with least possible rejects and its management. In this backdrop, the Central Pollution Control Board (CPCB), studied water treatment plants located across the country, for prevailing raw water quality, water treatment technologies, operational practices, chemical consumption and rejects management.

Karnal is a village located in Sangli district which is 7 km away from Sangli city having a total population of about 5878 in 2011. The village has a water treatment plant constructed to provide good quality water with sufficient quantity of water to its consumers. In this study, the efficiency of all the treatment units is evaluated by measuring suitable water quality parameters.

Water treatment plant of Karnal village has a cascade aerator which is in good condition which is followed by coagulation and flocculation unit. The settling tank is provided with tube settler followed by two rapid sand filter units chlorination is done after filtration. The whole water is collected in well present underground and the water is then pumped to an elevated storage reservoir for the supply. Following points were observed during the site visit.

At water treatment plant, the raw water is moderately turbid. At water treatment plant alum bricks are directly used without making alum solution. A non-mechanical device such as hydraulic jump is not used for mixing of chemicals. Paddles of flocculator mixer are used for mixing of chemicals. The settling tank is in a rectangular shape in which tube settlers are used. The plant has two rapid sand filters without any algae problem because of regular cleaning. Bleaching powder is used for chlorination. Chlorine dosing is often on approximation. As the residual chlorine at the farthest point of distribution is 0.2 -0.1 mg/lit represents no further contamination.

2) MATERIALS AND METHODS

The methodology consists of three phases such as Questionnaire survey, Field Studies and Compilation of Information. We have first visited the Karnal gram panchayat, district council Sangli and the villagers. We asked them about the present condition of the village and we got preliminary information about the village. We collected some documents about the WTP and some other information related to water distribution. We visited the water treatment plant of Karnal village, observed all units present over there and asked some questions to the WTP operator about working time, working of units, cleaning and maintenance. Water quality parameters such as Dissolved oxygen, pH, Turbidity, Total dissolved solids, Total suspended solids, Hardness, Acidity, Alkalinity, MPN, Chloride and Residual Chlorine were analyzed. The location of water sample collection for different parameters is mentioned in Table 1.
3) RESULT AND DISCUSSION

Water quality parameters such as Dissolved oxygen, pH, Turbidity, Total Dissolved Solids, Total suspended solids, Hardness, Acidity, Alkalinity, MPN, Chloride and Residual Chlorine were measured and shown in Table 1.

Dissolved oxygen
We have taken two sampling points for DO determination by Winkler’s method that is before aeration and after aeration. The maximum and minimum values of DO before aeration found are 8.04mg/l and 7.5mg/l respectively. And the maximum and minimum values of DO after aeration found are 8.9mg/l and 8.4mg/l respectively. Acceptable range as per IS.10500 (2012) is 4.5-7.5mg/l for the drinking purpose. So it is above limit no further measures required.

pH
For pH measurement using pH meter two sampling points taken that are before aeration and after chlorination. The maximum and minimum values of pH before aeration found are 8.39 and 7.9 respectively. The maximum and minimum values of pH after chlorination found are 8.5 and 7.69 respectively. The acceptable limit of pH according to IS.10500 (2012) is 6.5-8.5 so, it is within the range. The variation of pH is shown in Figure 1.

Turbidity
We have taken three sampling points for turbidity determination using Turbidity meters that are after aeration, after settling after filtration. The turbidity found are 9.134 NTU, 8.059 NTU and 3.73 NTU respectively and the acceptable range for turbidity as per IS.10500 (2012) after filtration is 1NTU for the drinking purpose. So it is not within limit hence suitable measures required for turbidity removal. The variation of turbidity is shown in Figure 2.

Total Dissolved Solids
The maximum value of TDS after aeration is 316mg/l. The minimum values of TDS after aeration, found are 287 mg/l. And the acceptable range for TDS as per IS. 10500 (2012) is 500mg/l for the drinking purpose. So it is within the limit. No suitable measures required for TDS removal. The variation of TDS is shown in Figure 3.

Hardness
We have taken a single sampling point for hardness determination by EDTA method that is after filtration. The maximum and minimum value of hardness found is 280mg/l and 265mg/l, and the acceptable range for hardness as per WHO 200mg/l for the drinking purpose. So it is not within limit. Suitable measures required for hardness removal. The variation of Hardness is shown in Figure 4.

Acidity
Total acidity of drinking water is needed to be maintained. More acidity causes undesirable taste and odour. We have taken a single sampling point for acidity determination using the titration method that is after filtration. It is found that mineral acidity is absent for all sample and total acidity is 28mg/lit. The variation of acidity is shown in Figure 5.
Alkalinity
Total alkalinity of drinking water is needed to be maintained. More alkalinity causes undesirable taste and odour. We have taken a single sampling point for alkalinity determination using the titration method that is after filtration. It is found that phenolphthalein alkalinity is absent for all sample and total alkalinity is 166.5mg/lit. The variation of alkalinity is shown in Figure 6.

MPN
This parameter is useful for quantifying the contamination of water by sewage. Also gives the amount of disinfection to kill bacteria.

We made two sampling point for MPN that is before and after chlorination. The maximum and minimum values of MPN before chlorination are 10 and 4/100ml. And the maximum and minimum values of MPN before chlorination are 2 and 0/100ml.

Chlorides
It indicates the pollution of water. Salinity is the total of all non-carbonate salts dissolved in water. We have taken a single sampling point for chloride determination that is before aeration. It is found that the maximum range is 54mg/l and the minimum range is 25mg/l which is within the limit. The variation of chlorides is shown in Figure 7.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Location</th>
<th>Max Value</th>
<th>Min Value</th>
<th>Acceptable IS 10500 (2012)</th>
<th>Permissible Limit</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissolved oxygen (mg/l)</td>
<td>Before aeration</td>
<td>8.4</td>
<td>7.5</td>
<td></td>
<td></td>
<td>Within Limit</td>
</tr>
<tr>
<td></td>
<td>After aeration</td>
<td>8.9</td>
<td>8.4</td>
<td>6.5</td>
<td></td>
<td>Within Limit</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>After aeration</td>
<td>9.35</td>
<td>6.74</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>After settling</td>
<td>8.45</td>
<td>3.78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>After filtration</td>
<td>5.74</td>
<td>2.1</td>
<td>1</td>
<td>5</td>
<td>Out of Limit</td>
</tr>
<tr>
<td>Total suspended solids (mg/l)</td>
<td>After aeration</td>
<td>375</td>
<td>312</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>After settling</td>
<td>170</td>
<td>142</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>After filtration</td>
<td>110</td>
<td>85</td>
<td>1000</td>
<td></td>
<td>Within Limit</td>
</tr>
<tr>
<td>Total dissolved solids (mg/l)</td>
<td>After aeration</td>
<td>316</td>
<td>287</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>After settling</td>
<td>160</td>
<td>140</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>After filtration</td>
<td>98</td>
<td>87</td>
<td>500</td>
<td>2000</td>
<td>Within Limit</td>
</tr>
<tr>
<td>Hardness (mg/l)</td>
<td>After filtration</td>
<td>280</td>
<td>265</td>
<td>200</td>
<td>600</td>
<td>Out of Limit</td>
</tr>
<tr>
<td>pH</td>
<td>Before aeration</td>
<td>8.39</td>
<td>7.9</td>
<td></td>
<td></td>
<td>No Relaxation</td>
</tr>
<tr>
<td></td>
<td>After chlorination</td>
<td>8.5</td>
<td>7.69</td>
<td>6.5-8.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acidity (mg/l)</td>
<td>Mineral acidity</td>
<td>Absent</td>
<td>Absent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total acidity</td>
<td>40</td>
<td>15</td>
<td>&lt;50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alkalinity (mg/l)</td>
<td>pH Alkalinity</td>
<td>Absent</td>
<td>Absent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total alkalinity</td>
<td>200</td>
<td>100</td>
<td>200</td>
<td>600</td>
<td>Within Limit</td>
</tr>
<tr>
<td>MPN</td>
<td>Before chlorination</td>
<td>10</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>After chlorination</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Chlorides (mg/l)</td>
<td>Before aeration</td>
<td>54</td>
<td>25</td>
<td>250</td>
<td>1000</td>
<td>Within Limit</td>
</tr>
</tbody>
</table>
4) PROBLEMS AND SOLUTION FOR WTP

Aerator
In the case of the aerator, there is large algal growth. This causes a decrease in oxygen level in the water. Algae consume oxygen present in water and if dissolved causes bad taste and odour. But still at present condition, the oxygen level is within range even though there is a considerable amount of growth of algae.

The solution to this problem is to clean and maintain the aerator periodically.

Coagulation
In the case of coagulation, the main problem is improper mixing of the alum in the water. Alum settles down in the coagulation tank. Alum bricks are directly placed for the mixing. Water is sprayed on the alum brick for dissolving alum brick in the coagulation unit. Because of this, turbidity and total suspended solids are not effectively removed. This resulted in high turbidity present in water as shown above.

The solution for this problem is to give the proper dosage of coagulant (alum) which is estimated by Jar Test, which was found as 30 mg/l. The solution of alum is prepared in a small tank. The flow of this solution is adjusted with the flow of water in such a way that a perfect dose of alum solution is achieved.

Flocculator
In the case of the flocculation tank, it is observed that the flocculator motor is hardly operated. This is the carelessness of the operator. Thus, there is no proper floc formation of the suspended solids and thus it affects the turbidity removal efficiency of treatment units. It also increases the load on the filtration process and affects the efficiency of the filtration unit. The filter run time is also reduced.

The solution to this problem is to operate the flocculator motor frequently. The proper coagulation time and speed of the propeller is to be given so that the flocs get easily formed. Since the motor should be in proper working condition.

Settling tank
In the case of settling tanks, the frequency of cleaning of the tube settlers is 2 months. The tube settlers are installed at 45 degrees. At 45 degrees, tube settlers are self-cleansing. The suspended solids slide down due to gravity and only the supernatant water is collected from the top. If some suspended solids are present on the tube settler then pressure jet of water is used to clean the tube settlers.

Filtration
In the filtration unit, turbidity is not efficiently removed. Also, the filtration unit requires 70,000 liters of filtered water daily for backwashing. Backwash water is not reused and directly disposed of into the sewer.

The solution to this problem is to recirculate the backwashed water just after the aeration and before coagulation to increase the turbidity considerably. This will cause an increase in efficiency of alum dosage by forming bigger flocs.

Hardness
The problem of hardness persists even after all the processes. It exceeds the desirable limit of 200 mg/l. No available treatment unit can remove the hardness from the water. Thus, the zeolite process is to be used to remove the hardness of the water. By zeolite process, the hardness of water is reduced almost to zero. Zeolite is a complex compound of aluminum, silica and soda. Hard water is passed through a bed of ion exchange material commonly known as zeolite. Calcium and magnesium are removed from the water as these are substituted by sodium by the ion exchange process.

5) CONCLUSIONS

In the analysis of the water treatment plant, it is found that all the parameters are in within range except turbidity and hardness. To bring turbidity in acceptable limits, proper coagulation, flocculation, sedimentation and filtration is needed.

There is large algal growth which causes a decrease in oxygen level in water because algae consume oxygen present in water.

The main problem in the coagulation process is improper mixing of the alum in the water. Alum settles down in the coagulation tank.

The hardness of the water is also more than acceptable limits.

ACKNOWLEDGMENT

It’s a genuine pleasure to express my thanks to my colleague, Prof. K. H. Ghorpade, Prof. S. R. Kate, Prof. A. A. Burade and Prof. J. S. Athalye, Trinity Academy of Engineering, Pune. Their timely, scholarly advice, meticulous scrutiny and scientific approach helped me to a very great extent to accomplish this task.

I would also thank my HOD Dr. S. S. Deshmukh and Principal Dr. N. J. Uke and Institution for unconditional support.

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An Experimental Study on Effect of Sea Water on Compressive Strength of Concrete

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\textbf{ABSTRACT} This research work seeks to investigate the use of sea water as mixing and curing of concrete as 97\% of the water on Earth surface is sea water and commonly water used for concreting is water from boreholes which contains number of salts and hence we are testing it for extreme case i.e. sea water case. For this concrete cubes were cast for a design mix of M-20, and M-25, using Ordinary Portland Cement (43 grade), Ordinary Portland Cement (53 grade) and Pozzolana Portland Cement. Three exposure conditions used, “mixing and curing with potable water”, “mixing and curing with sea water”, “mixing with potable water and curing with sea water”. The cubes were cast and cured for 3, 7, 14, 21, 28 days and was tested for compressive strength.

\textbf{INDEX TERMS} Compressive strength, concrete cubes, curing, design mix, mixing, potable water,

\textbf{INTRODUCTION}

Concrete is referred as artificial stone and is made from the mixture of cement, aggregate, sand, admixtures and water to form a uniform plastic material which sets gradually and gains strength with time.

With time all the natural resources are becoming scarce and water is one of them. According to the literatures available, it is said that in 2025, the half of the world will not have water even for daily necessities. Globally, billion of tons of water is used in concrete industry. Also, United Nations (UN) and World Metrological Organization (WHO) have predicted that 5 billion people will be in short of even drinking water. So, there is a need to explore alternative for potable water in construction industry. A large number of structures are exposed to seawater either directly or indirectly. Thus, possibility of usage of sea water in concrete is studied.

In the present study, concrete with various types of cement adopted. Concrete grades of M-20 and M-25 design mix with a slump in between 75 to 100 mm were considered in the study. The exposure conditions of “Concrete mixing and curing with potable water”, “Concrete mixing and curing with sea water” and “Concrete mixing with potable water and curing with sea water” were adopted.

1. \textbf{NECESSITY OF PROJECT}

As population increases, demands of people increases and it becomes difficult to maintain balance between the demands and sustainable environment. Supply of fresh water is finite and predications say that in near future there will be shortage of drinking water. Hence, fresh water will not be available for concreting purpose. We use bore water for mixing as well as curing of concrete instead of fresh water. The bore water available is neither free from impurities nor is considered as soft water. Here in this research work we are working on the effect of sea water as mixing and curing on concrete.

\textbf{LITERATURE STUDY}

According to Water Encyclopaedia (2012), great bodies of water covers about five seventh of the earths’ surface about 71 \% in some places to depth more than ten kilometres. Adebakin, H. I. (2003) describes fresh water as purified water which is free from impurities. Akinkurolere O.O et.al (2007) said sea water is a complex solution of many salts containing living matter, suspended silt, dissolved gases and decaying organic material. The average salt concentration of sea water is about 3.5\% depending upon its location. The concentration of major salt constituents of seawater we are given in weight \% of salt as 78\%NaCl, 10.5\% MgCl\textsubscript{2}, 5\% MgsSO\textsubscript{4}, 3.9\% CaSO\textsubscript{4}, 2.3\% K2SO\textsubscript{4} and 0.3\% KBr.

Studies were conducted during past on effect of mixing and curing of sea water in concrete. Falah M. Wegian (2010) investigated the effects of mixing and curing concrete with sea water on the compressive, tensile, flexural and bond strengths and reported that there are increases of strengths of concrete mixed and cured in sea water at early ages and a definite decrease for ages more than 28 days and up to 90 days. Donald F. Griffin et.al (1964) concluded that a small amount of sea water salts may be to concrete if rigid controls are exercised. Maximum compressive strength occurs between salinities of 18 and 36 gm/kg for concrete incorporating NaCl in the mixing water. Natural sea water does not deteriorate plain concrete; strength is generally increased with salinities up to nearly three times that of natural water. Nobuaki Otsuki et.al (2011) concluded from the test results and discussions and are confident to safely use sea water as mixing water. P. Krishnam Raju et.al (2014) concluded that there is no reduction in compressive
strength due to mixing and curing of sea water, whereas the average compressive strength arrived for designated concretes are more than the target strength. O.O. Akinkurolere et.al (2007) concluded that concrete cast with sea water and cured with sea water increases the 28 days compressive strength dramatically and linearly beyond that obtained when cast in fresh water and cured in fresh water. Preeti Tiwari et.al (2014) performed series of experiments on M-30 grade and said that there is marginal increase in the strength of cubes cast and cured in salt water as compared to those of cast and cured in fresh water at all ages of curing and concluded that there is no reduction in the strength if we use salt water casting and curing the concrete. F. Adeyemiet. al. (2014) concluded that the strength of concrete batches cast with salt water and cured with fresh water was also observed to have increased even at 28 days and 90 days respectively. K. J. Kucche et.al (2015) quoted that from stream, river and even sea is also suitable, if it not contain brackish matter. TarekUddin Mohammed et.al said that seawater-mixed concrete shows earlier strength gain compared to the tap water-mixed concrete. However, after a long-term of exposure, no significant difference in compressive strength is observed.

MATERIALS AND METHODOLOGY

MATERIALS

The details of various materials used in the experimental investigation were:

- Coarse Aggregate:-Crushed granite stone aggregate of maximum size 20 mm confirming to IS 383-1970 was used. The specific gravity was found to be 2.925.
- Sand (Fine Aggregate):- The fine aggregate used was sand passing through 4.75 mm sieve. The specific gravity was found to be 2.83. The grading zone of fine aggregate was zone I as per IS specification.
- Cement:-Ordinary Portland Cement (43 grade), Ordinary Portland Cement (53 grade), Pozzolana Portland Cement (Ultratech Cement) was used.
- Water:- Ordinary clean potable water free from suspended particles and chemicals was used for mixing and curing of concrete.
- Sea water:-Seawater is water from a sea or ocean. Here sea water from Arabian Sea was used.

METHODOLOGY

Initial and Final Setting Time of Cement: Initial setting time is regarded as the time elapsed between the moment water is added to the cement, to the time that the paste starts losing its plasticity. The final setting time is the time elapsed between the moment the water is added to the cement, and the time when the paste has completely lost its plasticity and has attained sufficient firmness to resist certain definite pressure. The effect of sea water on the setting time of cement was also observed.

EXPERIMENTAL PROCEDURE

To investigate the effect of sea water on compressive strength of concrete, three exposure conditions were used. The concrete cube size measuring 150x150x150 mm in dimension will be used. The batching of the concrete was carried out by weight. The mix proportion was calculated for characteristic compressive strength of 20 N/mm² and 25 N/mm². The concrete was properly mixed using the sea water and potable water respectively, the concrete cubes mould were filled in three layers. In each of the layer, the concrete cubes will be compacted 25 times respectively. The concrete cubes were cast and cured for 3.7, 14, 21 and 28 days and will be tested for compressive strength.

Workability: Workability of cubes mixed with sea water and potable water are measured separately before casting of cubes. The workability maintained was medium i.e. slump was maintained between 75 mm to 100 mm for mass concrete.

Compressive Strength: The compressive strength is taken as maximum compressive load resisted by per unit area. For each of the curing period of 3, 7, 14, 21 and 28 days, cubes were tested and the average compressive strength recorded. The concrete cubes were tested in “Compression Testing Machine of capacity 2000 kN. The tests were carried out at “Vidya Vikas Pratishthan (VVP) Polytechnic, Solapur”.

Test Results: The observations for setting time of cement, workability of fresh concrete and compressive strength of hardened concrete are given in the following tables.

<table>
<thead>
<tr>
<th>Table 1: Observations for Setting Time of Cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting Time</td>
</tr>
<tr>
<td>Initial</td>
</tr>
<tr>
<td>Final</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2 : Observations for Slump Cone Test of Fresh Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slump of Concrete (mm)</td>
</tr>
<tr>
<td>M-20 Grade of concrete using Ordinary Portland Cement (43 Grade)</td>
</tr>
<tr>
<td>Grade</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Figure 1: Graph Showing Results for Slump Cone Test on Concrete

Table 3: Quantities of Materials for Casting of 15 Cubes of M-20 Grade Concrete

<table>
<thead>
<tr>
<th>Grade</th>
<th>M-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportions</td>
<td>1 : 1.777 : 2.825</td>
</tr>
<tr>
<td>W/C Ratio (Potable/Sea)</td>
<td>0.47</td>
</tr>
<tr>
<td>Cement</td>
<td>32 kg</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td>56.864 kg</td>
</tr>
<tr>
<td>Coarse Aggregate</td>
<td>90.4 kg</td>
</tr>
<tr>
<td>Water (Potable/Sea)</td>
<td>16 kg</td>
</tr>
</tbody>
</table>

Table 4: Results for M-20 Grade of Concrete Using Ordinary Portland Cement (43 Grade)

<table>
<thead>
<tr>
<th>Age in Days</th>
<th>Average Compressive Strength (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mixing and Curing with Potable Water</td>
</tr>
<tr>
<td>7 Days</td>
<td>20.351</td>
</tr>
<tr>
<td>14 Days</td>
<td>27.759</td>
</tr>
<tr>
<td>21 Days</td>
<td>30.338</td>
</tr>
<tr>
<td>28 Days</td>
<td>32.055</td>
</tr>
</tbody>
</table>

Figure 2: Test Results for M-20 Grade Concrete Using Ordinary Portland Cement (43 Grade)

Table 5: % Increase in Average Compressive Strength of M-20 Grade of Concrete Using Ordinary Portland Cement (43 Grade)

<table>
<thead>
<tr>
<th>Age in Days</th>
<th>% Increase in Average Compressive Strength when Mixed and Cured with Sea Water (N/mm²)</th>
<th>% Increase in Average Compressive Strength when Mixed with Potable Water and Cured with Sea Water (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Days</td>
<td>7.0137</td>
<td>5.0025</td>
</tr>
<tr>
<td>7 Days</td>
<td>4.1619</td>
<td>2.5208</td>
</tr>
<tr>
<td>14 Days</td>
<td>9.1393</td>
<td>5.9008</td>
</tr>
<tr>
<td>21 Days</td>
<td>5.1321</td>
<td>3.817</td>
</tr>
<tr>
<td>28 Days</td>
<td>-2.9667</td>
<td>-0.2808</td>
</tr>
</tbody>
</table>
Figure 3: % Increase in Average Compressive Strength of M-20 Grade of Concrete Using Ordinary Portland Cement (43 Grade)

Table 6: Results for M-20 Grade of Concrete Using Ordinary Portland Cement (43 Grade)

<table>
<thead>
<tr>
<th>Age in Days</th>
<th>Mixing and Curing with Potable Water</th>
<th>Mixing and Curing with Sea Water</th>
<th>Mixing with Potable Water and Curing with Sea Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Days</td>
<td>10.892</td>
<td>12.089</td>
<td>11.769</td>
</tr>
<tr>
<td>7 Days</td>
<td>20.979</td>
<td>22.266</td>
<td>21.869</td>
</tr>
<tr>
<td>14 Days</td>
<td>28.191</td>
<td>31.297</td>
<td>30.598</td>
</tr>
<tr>
<td>21 Days</td>
<td>30.939</td>
<td>33.357</td>
<td>32.518</td>
</tr>
<tr>
<td>28 Days</td>
<td>32.811</td>
<td>33.175</td>
<td>33.491</td>
</tr>
</tbody>
</table>

Table 7: % Increase in Average Compressive Strength of M-20 Grade of Concrete Using Ordinary Portland Cement (53 Grade)

<table>
<thead>
<tr>
<th>Age in Days</th>
<th>% Increase Average in Compressive Strength when Mixed and Cured with Sea Water (N/mm²)</th>
<th>% Increase in Average Compressive Strength when Mixed with Potable Water and Cured with Sea Water (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Days</td>
<td>10.9897</td>
<td>8.0518</td>
</tr>
<tr>
<td>7 Days</td>
<td>6.1347</td>
<td>4.2423</td>
</tr>
<tr>
<td>14 Days</td>
<td>11.0177</td>
<td>8.5381</td>
</tr>
<tr>
<td>21 Days</td>
<td>7.8154</td>
<td>5.1036</td>
</tr>
<tr>
<td>28 Days</td>
<td>1.1094</td>
<td>2.0725</td>
</tr>
</tbody>
</table>
Table 8: Results for M-20 Grade of Concrete Using Ordinary Portland Cement (53 Grade)

<table>
<thead>
<tr>
<th>Age in Days</th>
<th>Mixing and Curing with Potable Water</th>
<th>Mixing and Curing with Sea Water</th>
<th>Mixing with Potable Water and Curing with Sea Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Days</td>
<td>9.811</td>
<td>10.209</td>
<td>10.209</td>
</tr>
<tr>
<td>7 Days</td>
<td>20.772</td>
<td>21.557</td>
<td>21.557</td>
</tr>
<tr>
<td>14 Days</td>
<td>28.121</td>
<td>29.872</td>
<td>29.872</td>
</tr>
<tr>
<td>21 Days</td>
<td>30.911</td>
<td>32.18</td>
<td>32.18</td>
</tr>
<tr>
<td>28 Days</td>
<td>32.062</td>
<td>31.836</td>
<td>31.836</td>
</tr>
</tbody>
</table>

Figure 6: Test Results for M-20 Grade Concrete Using Pozzolana Portland Cement

Table 9: % Increase in Average Compressive Strength of M-20 Grade of Concrete Using Pozzolana Portland Cement

<table>
<thead>
<tr>
<th>Age in Days</th>
<th>% Increase Average in Compressive Strength when Mixed and Cured with Sea Water (N/mm²)</th>
<th>% Increase in Average Compressive Strength when Mixed with Potable Water and Cured with Sea Water (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Days</td>
<td>9.4282</td>
<td>4.0567</td>
</tr>
<tr>
<td>7 Days</td>
<td>5.0934</td>
<td>3.7791</td>
</tr>
<tr>
<td>14 Days</td>
<td>9.8005</td>
<td>6.2267</td>
</tr>
<tr>
<td>21 Days</td>
<td>5.4705</td>
<td>4.1053</td>
</tr>
<tr>
<td>28 Days</td>
<td>-0.9138</td>
<td>-0.7049</td>
</tr>
</tbody>
</table>

Figure 7: % Increase in Average Compressive Strength of M-20 Grade of Concrete Using Pozzolana Portland Cement

Table 10: Quantities of Materials for Casting of 15 Cubes of M-25 Grade Concrete

<table>
<thead>
<tr>
<th>Grade</th>
<th>M-25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportions</td>
<td>1 : 1.777 : 2.825</td>
</tr>
<tr>
<td>W/C Ratio (Potable/Sea)</td>
<td>0.47</td>
</tr>
<tr>
<td>Cement</td>
<td>32 kg</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td>56.864 kg</td>
</tr>
<tr>
<td>Coarse Aggregate</td>
<td>90.4 kg</td>
</tr>
<tr>
<td>Water (Potable/Sea)</td>
<td>16 kg</td>
</tr>
</tbody>
</table>
Table 11: Results for M-25 Grade of Concrete Using Ordinary Portland Cement (43 Grade)

<table>
<thead>
<tr>
<th>Age in Days</th>
<th>Mixing and Curing with Potable Water</th>
<th>Mixing and Curing with Sea Water</th>
<th>Mixing with Potable Water and Curing with Sea Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Days</td>
<td>10.944</td>
<td>11.932</td>
<td>11.71</td>
</tr>
<tr>
<td>7 Days</td>
<td>24.045</td>
<td>25.422</td>
<td>25.255</td>
</tr>
<tr>
<td>14 Days</td>
<td>32.242</td>
<td>35.685</td>
<td>34.543</td>
</tr>
<tr>
<td>21 Days</td>
<td>35.804</td>
<td>36.625</td>
<td>36.88</td>
</tr>
<tr>
<td>28 Days</td>
<td>37.572</td>
<td>35.672</td>
<td>37.685</td>
</tr>
</tbody>
</table>

Figure 8: Test Results for M-25 Grade Concrete Using Ordinary Portland Cement (43 Grade)

Table 12: % Increase in Average Compressive Strength of M-25 Grade of Concrete Using Ordinary Portland Cement (43 Grade)

<table>
<thead>
<tr>
<th>Age in Days</th>
<th>% Increase in Average Compressive Strength when Mixed and Cured with Sea Water (N/mm²)</th>
<th>% Increase in Average Compressive Strength when Mixed with Potable Water and Cured with Sea Water (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Days</td>
<td>9.0278</td>
<td>6.9992</td>
</tr>
<tr>
<td>7 Days</td>
<td>5.7268</td>
<td>5.0322</td>
</tr>
<tr>
<td>14 Days</td>
<td>10.6786</td>
<td>7.1366</td>
</tr>
<tr>
<td>21 Days</td>
<td>2.293</td>
<td>3.0052</td>
</tr>
<tr>
<td>28 Days</td>
<td>-5.0569</td>
<td>0.3008</td>
</tr>
</tbody>
</table>

Figure 9: % Increase in Average Compressive Strength of M-25 Grade of Concrete Using Ordinary Portland Cement (43 Grade)

Table 13: Results for M-25 Grade of Concrete Using Ordinary Portland Cement (53 Grade)

<table>
<thead>
<tr>
<th>Age in Days</th>
<th>Mixing and Curing with Potable Water</th>
<th>Mixing and Curing with Sea Water</th>
<th>Mixing with Potable Water and Curing with Sea Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Days</td>
<td>12.335</td>
<td>13.471</td>
<td>13.032</td>
</tr>
<tr>
<td>7 Days</td>
<td>24.502</td>
<td>26.257</td>
<td>25.977</td>
</tr>
<tr>
<td>14 Days</td>
<td>32.734</td>
<td>36.792</td>
<td>36.171</td>
</tr>
<tr>
<td>21 Days</td>
<td>36.418</td>
<td>37.884</td>
<td>39.033</td>
</tr>
<tr>
<td>28 Days</td>
<td>37.884</td>
<td>37.632</td>
<td>38.418</td>
</tr>
</tbody>
</table>
Table 14: % Increase in Average Compressive Strength of M-25 Grade of Concrete Using Ordinary Portland Cement (53 Grade)

<table>
<thead>
<tr>
<th>Age in Days</th>
<th>% Increase in Average Compressive Strength when Mixed and Cured with Sea Water (N/mm²)</th>
<th>% Increase in Average Compressive Strength when Mixed with Potable Water and Cured with Sea Water (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Days</td>
<td>9.2096</td>
<td>5.6506</td>
</tr>
<tr>
<td>7 Days</td>
<td>7.1627</td>
<td>6.0199</td>
</tr>
<tr>
<td>14 Days</td>
<td>12.3969</td>
<td>10.5</td>
</tr>
<tr>
<td>21 Days</td>
<td>4.0255</td>
<td>7.1805</td>
</tr>
<tr>
<td>28 Days</td>
<td>-0.6652</td>
<td>1.4097</td>
</tr>
</tbody>
</table>

Table 15: Results for M-25 Grade of Concrete Using Pozzolana Portland Cement

<table>
<thead>
<tr>
<th>Age in Days</th>
<th>Mixing and Curing with Potable Water</th>
<th>Mixing and Curing with Sea Water</th>
<th>Mixing with Potable Water and Curing with Sea Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Days</td>
<td>11.642</td>
<td>12.536</td>
<td>12.252</td>
</tr>
<tr>
<td>7 Days</td>
<td>24.303</td>
<td>25.804</td>
<td>25.631</td>
</tr>
<tr>
<td>14 Days</td>
<td>32.675</td>
<td>35.954</td>
<td>35.106</td>
</tr>
<tr>
<td>21 Days</td>
<td>36.239</td>
<td>37.398</td>
<td>38.063</td>
</tr>
<tr>
<td>28 Days</td>
<td>37.8</td>
<td>36.533</td>
<td>37.193</td>
</tr>
</tbody>
</table>
Table 16: % Increase in Average Compressive Strength of M-25 Grade of Concrete Using Pozzolana Portland Cement

<table>
<thead>
<tr>
<th>Age in Days</th>
<th>% Increase in Average Compressive Strength when Mixed and Cured with Sea Water (N/mm²)</th>
<th>% Increase in Average Compressive Strength when Mixed with Potable Water and Cured with Sea Water (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Days</td>
<td>7.6791</td>
<td>5.2396</td>
</tr>
<tr>
<td>7 Days</td>
<td>6.1762</td>
<td>5.4643</td>
</tr>
<tr>
<td>14 Days</td>
<td>10.0352</td>
<td>7.4399</td>
</tr>
<tr>
<td>21 Days</td>
<td>3.3198</td>
<td>5.0333</td>
</tr>
<tr>
<td>28 Days</td>
<td>-3.3518</td>
<td>-1.6058</td>
</tr>
</tbody>
</table>

CONCLUSION

● There was an increase in initial and final setting time of cement when cement is mixed with sea water but it satisfies the IS specification clause of initial and final setting time of cement.
● The condition medium workability attained by using sea water for mixing of concrete.
● After casting and demoulding, the sea water concrete cubes has a darker surface than the reference concrete cubes, when cured in sea water a deposit of salt formed on a specimens.
● Series of experiments were conducted on M-20 and M-25 grade of concrete using Ordinary Portland Cement (43 grade), Ordinary Portland Cement (53 grade) and Pozzolana Portland Cement. From the results it can be said that, there is an increase in the of compressive strength of concrete cubes at early ages which were cast and cured with sea water as compared with the concrete cubes cast and cured with potable water. The strength increases by 4-10% at 3 days, 4-8% at 7 days and 6-13% at 14 days.
● Reduction in strength for the exposure condition “Concrete mixing with potable water and curing with sea water” is less than that for “Concrete mixing and curing with sea water”
● There is no remarkable reduction in compressive strength due to mixing with potable water and curing the concrete with sea water or mixing and
curing of the concrete with sea water, the strength decreases by about 0.3-5% at 28 days when sea water is used as compared to characteristic target strength when concrete mixed and cured with potable water.

- The reduction of strength percentage is most for Pozzolana Portland Cement and least for Ordinary Portland Cement (53 grade) for both M-20 and M-25 grade of concrete.

- Studies may be carried out for higher grades of concrete i.e. M-30 and above and other types of cements, other types of admixtures and ground granulated blast furnace slag cements etc.

From the above finding we can conclude that there is no remarkable variation in the compressive strength if sea water is used for casting and curing the concrete. This concrete can be safely used for mass concrete without any alteration in strength properties.

Long term studies may also be carried out to investigate the durability aspects when sea water is used both for mixing and curing. Studies may be carried out for flexure strength and split tensile strength.

ACKNOWLEDGMENT

This project arranged and supported by our directing staff we are thankful to HOD and all the staff members who have contributed and confident in completing. Last but not least, we would like to thanks all those who directly and indirectly involed in this project.

REFERENCES


Comparative Study of Fly Ash & RBI Grade 81 on Lateritic Soil (May 2020)

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⁴Dept. of Civil Engineering, Gharda Institute of Technology, Lavel, Khed, Maharashtra, India, 415708.
⁵Dept. of Civil Engineering, Gharda Institute of Technology, Lavel, Khed, Maharashtra, India, 415708.

ABSTRACT
In most of the failure cases, the soil does not have sufficient strength & bearing capacity to sustain under traffic load, natural disasters (earthquake, heavy rain, flood, landslides), structure. So, attempt is to modify & improve the properties of Lateritic Soil by adding fly ash & RBI Grade 81; where fly ash is industrial waste & RBI-81 (Road Building International Grade 81) is a soil stabilizer. To check the influence of fly ash & RBI-81 on index & engineering properties, we have performed tests like core cutter method, oven dry method, sieve analysis, density bottle test, liquid limit, plastic limit also MDD, compaction test, triaxial test, CBR tests with available laboratory equipments. Both are used in varying percentages from 1% to 5% by weight at optimum percentage of water. As per results, 4% of fly ash, 3% of RBI-81 and 2% of combined sample (fly ash&RBI-81) are found to be at optimum for sub-base regarding IRC recommendation. Also, Fly Ash sample gives increment in CBR value by 13.62% than untested soil sample, whereas RBI-81 shows 26.49% & combination sample gives 24.69% increment in CBR value. By observation, it can be concluded that addition of RBI-81 has greater % value of improvement. Therefore, RBI-81 is more suitable than Fly ash & combination sample (fly ash&RBI-81) based on strength criteria. From above summary, we can conclude that addition of Fly Ash & RBI Grade 81 on lateritic soil has improved its properties resulting improvement in soil’s bearing capacity.

INDEX TERMS
Bearing capacity, CBR, fly ash, lateritic soil, MDD, RBI Grade 81, stabilizer, strength.

1. INTRODUCTION

Soil is a naturally available material. It is the fundamental element to build any structure. It is the ultimate body which supports the whole structure of road pavement, foundations or any other. Since it gets changes in its properties from region to region due to weathering actions, it has complex nature, so it is important to study about its response to load coming from road or structure resting on it. Also, to adopt suitable type of techniques and equipments at the time of construction. It possesses index and engineering properties which shows its nature & behavior under certain action of load.

In most failure cases, when subjected to traffic load, natural disasters etc. the soil does not have sufficient strength may be because of atmospheric interference, improper design of pavement for subbase. Also, it is observed that, soil is unable to sustain after its maximum bearing capacity is utilized. In result, shear and cracks may get developed. Here, locally available soil is selected which is lateritic soil. As it has very low plasticity, high moisture content and high permeability due to which it forms difficulties in construction mostly in konkan areas. Hence, it is necessary to modify or stabilize its properties. It can be strengthened or improved by adding supplementary materials or stabilizers. Here, fly ash & RBI Grade 81 are used; where, fly ash is industrial waste product & RBI-81 is a soil stabilizer. In India, fly ash is generated in number of tons. However, the disposal problem is covered. The purpose of our project, to check the effects of fly ash & RBI-81 on lateritic soil.

All tests are conducted with available laboratory equipments. Therefore, following the title of study, results are compared, concluded and represented on the basis of strength improvement aspect.

A. LATERITIC SOIL

Commonly formed in hot and wet tropical areas developed under prolonged weathering. It has low plasticity, high moisture content and high permeability due to sandy nature. Also, rich in iron & aluminum content.

B. FLY ASH

It is generated during the combustion of pulverized coal in the thermal power plants and waste product of chemical industry. Here, f-class fly ash is used.

C. RBI GRADE 81

It is a Road Building International Grade 81 construction material patented worldwide known as a soil stabilizer. It is a cementitious powder form which is grey in color which also acts as waste binding.
2. METHODOLOGY

The soil sample having undisturbed properties was collected from site. The soil sample was subjected to go under various tests for further analysis regarded by IS-code: 2720 for selection of methodology. We have done some experimental work; the assembly is as follows:

A. CORE CUTTER METHOD

This method was used to determine the dry density of sample (lateritic soil). Density is defined as the mass per unit volume of soil. For present sample, procedure was followed as per recommendations mention in IS-code: 2720, Part 5 and dry density of locally available soil was resulted.

B. OVEN DRYING METHOD

This method was used to determine moisture content of sample (lateritic soil). For present sample, procedure was followed as per recommendations mention in IS-code: 2720, Part 4 and moisture content of locally available soil was resulted.

C. GRAIN SIZE DISTRIBUTION

Sieve analysis was done to identify the classification of soil whether it is well graded or poorly graded soil. As per IS-code: 2720-Part 6, we have made an analysis & plotted a grain size distribution curve showing gradation of soil where the result is depending upon the value of coefficient of curvature and uniformity coefficient. The grain size distribution curve is represented in fig. 1.

D. DENSITY BOTTLE METHOD

This method was used to calculate specific gravity of soil, procedure followed by IS-code:2720, Part 7.

E. LIQUID LIMIT

This test was used to determine the liquid limit of sample (lateritic soil). This is the limiting moisture content at which the cohesive soil passes from liquid state to plastic state. This was found by following IS-code:2720, Part 11. Here is an analytical graph shown in fig. 2.

F. PLASTIC LIMIT

The plastic limit test of a soil was used to determine the moisture content, expressed as a percentage of the weight of the oven dry soil procedure followed by IS-code:2720, Part-11.

G. CBR TEST

The California Bearing Ratio (CBR) test is a penetration test used to evaluate the subgrade strength of roads and pavements followed by IS-code:2720, Part 16. This test is done on the lateritic soil with addition of fly ash & RBI grade 81, combination of both and without addition of both materials. A standard metal rammer (IS:9198-1979) is used for compaction.

Preparation of Sample:
1) Lateritic Soil Sample:
   • Take about 3.2 kg of lateritic soil and mixed with the 17% of water.
   • Fix the extension collar and the base plate to the mould. Insert the spacer disc over the base. Place the filter paper on the top the spacer disc.
   • Compact the mix soil in the mould using light compaction. For light compaction, compact the soil in 3 equal layers, each layer is being given 56 blows by 2.48 kg rammer remove the collar and trim off soil.
   • Turn the mould upside down and remove the base plate and the displacer disc. Weight the mould with compacted soil (collar side) and clamp the perforated base plate on to it.
   • Place the mould assembly with the surcharge weights on the penetration test machine. Seat the penetration piston at the center of the specimen with full contact of the piston on the sample is established. Set the stress and strain dial gauge to read zero.
   • Apply the load on the piston so that the penetration rate is about 1.25 mm/min. Records the load readings at penetrations of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5 & 5.0 mm.

2) Lateritic soil + Fly Ash Sample:
   • Take about 3.2 kg of lateritic soil and 1% of Fly ash in addition of 17% of water content; mix them well.
   • Follow 2,3,4,5,6 steps for further procedure.
   • Follow above procedure for 2%, 3%, 4%, 5%.
Above procedure was followed for Lateritic soil+RBI-81 samples where for combination sample (lateritic soil + fly ash + RBI-81) rest of procedure remains same excepts % of water that becomes 15% and there is contribution of 1% from fly ash and RBI-81 each.

**H. PROCTOR COMPACTION TEST (MDD)**

This method covers the determination of the relationship between the moisture content and density of soils compacted (2.5kg rammer dropped from a height of 30cm). MDD was determined as per IS-code:2720, Part 8.

**I. TRIAXIAL SHEAR TEST**

The triaxial compression test is more commonly used in laboratory for determination of shear strength. Test is followed by IS-code:2720, Part 11.

Graphical Analysis: On the basis of experimental work, all the result summery is represented in table no.1 & 2 also, the comparative representation is done for analysis purpose as follows:

**RESULT**

From all experimental work, a tabular summery is as follows which consists of two tables corresponding results from index properties.

**TABLE I-A**

**TESTING RESULTS FOR INDEX PROPERTIES**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Particulars</th>
<th>Quantities with units</th>
<th>Type of method</th>
<th>Remark</th>
<th>IS Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Dry Density of Soil</td>
<td>1.26 gm/cc</td>
<td>Core Cutter Method</td>
<td>-</td>
<td>IS 2720</td>
</tr>
<tr>
<td></td>
<td>(f_d)</td>
<td></td>
<td></td>
<td>Part 5</td>
<td>Part 5</td>
</tr>
<tr>
<td>2.</td>
<td>Moisture Content (W)</td>
<td>33.33 %</td>
<td>Oven Dry Method</td>
<td>-</td>
<td>IS 2720</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Part 4</td>
<td>Part 4</td>
</tr>
<tr>
<td>3.</td>
<td>Grain Size Distribution</td>
<td>C_c = 0.81 \ C_u = 17.02</td>
<td>Sieve Analysis</td>
<td>It is well graded medium uniform sandy soil group sand.</td>
<td>IS 2720</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Part 6</td>
<td>Part 6</td>
</tr>
<tr>
<td>4.</td>
<td>Specific Gravity (G)</td>
<td>2.11</td>
<td>Density Bottle Method</td>
<td>-</td>
<td>IS 2720</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Part 7</td>
<td>Part 7</td>
</tr>
<tr>
<td>5.</td>
<td>Liquid Limit</td>
<td>50 %</td>
<td>Liquid Limit Test</td>
<td>-</td>
<td>IS 2720</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Part11</td>
<td>Part11</td>
</tr>
<tr>
<td>6.</td>
<td>Plastic Limit</td>
<td>33.33 %</td>
<td>Plastic Limit Test</td>
<td>-</td>
<td>IS 2720</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Part11</td>
<td>Part11</td>
</tr>
</tbody>
</table>

In following table, CBR results are finalized on basis of IRC recommendation or on specific conditions from all of samples of varying percentages compared in bar representation in statistical analysis.
### TABLE I-B
**TESTING RESULTS FOR ENGINEERING PROPERTIES**

<table>
<thead>
<tr>
<th></th>
<th>CBR</th>
<th>2.5mm</th>
<th>5.0mm</th>
<th>Soil range without addition of material.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CBR</td>
<td></td>
<td></td>
<td>Here, swelling effect is considered.</td>
</tr>
<tr>
<td></td>
<td>Test</td>
<td></td>
<td></td>
<td>CBR values between 20% - 30% are accepted here as per IRC recommendation for sub-base.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IS 2720 Part 16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. a) Laterite only</td>
<td>40.44%</td>
<td>37%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. b) Laterite + Fly ash</td>
<td>36.43%</td>
<td>34.80%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. c) Laterite + RBI Grade 81</td>
<td>30.98%</td>
<td>29.45%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. d) Laterite + Fly ash + RBI Grade 81</td>
<td>31.55%</td>
<td>28.68%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Maximum Dry Density (MDD)</td>
<td>1.856 gm/cc</td>
<td></td>
<td></td>
<td>IS 2720 Part 8</td>
</tr>
<tr>
<td>7. Triaxial Shear Test</td>
<td>C=6.8 KN/m², Ø=29°</td>
<td></td>
<td></td>
<td>IS 2720 Part 11</td>
</tr>
</tbody>
</table>

**Comparative Representation of Results:**

It is a Graphical representation of samples Fly Ash, RBI Grade 81 and combination of fly ash & RBI Grade 81 based on difference of percentages at which composition is found to be most improved from 1% to 5% taken at 2.5mm; in which Fly Ash has CBR value improved by 13.62% than plain soil sample, whereas RBI-81 shows 26.49% & combination sample gives 24.69% as shown by following graph,
DISCUSSION

From all results obtained by performing laboratory test, we can successfully aim objectives of our project. We are able to compare CBR values and find out which sample has comparatively more improved % of CBR value which shows bearing capacity of soil has improved. We have studied effect of fly ash and RBI-81 on lateritic soil. We can say that, properties of lateritic soil are improved.

4. CONCLUSIONS

- From the CBR results, optimum value for fly ash is recorded to be 35.28% for 4% @2.5mm penetration when compared to results at 1%, 2%, 3%, 4%, 5%.
- From the CBR results, optimum value for RBI Grade 81 is recorded to be 30.98% for 3% @2.5mm penetration when compared to results at 1%, 2%, 3%, 4%, 5%.
- From the CBR results, optimum value for combined sample Fly ash & RBI Grade 81 is recorded to be 31.55% for 2% @2.5mm penetration when compared to results at 1%, 2%, 3%, 4%, 5%.
- Hence, we concluded that the 4% of fly ash, 3% of RBI Grade 81 and 2% of combined sample fly ash & RBI Grade 81 are found to be appropriate in order to achieve the objectives of our project i.e. to improve properties and bearing capacity of locally available lateritic soil.
- From graphical representation, Fly Ash sample gives increment in CBR value by 13.62% than untested soil sample, whereas RBI-81 shows 26.49% & combination sample gives 24.69% increment in CBR value. By observation, it can be concluded that addition of RBI-81 has found to be greater % of improvement value than fly ash and combination sample.
Therefore, RBI-81 is more suitable than Fly ash & combination sample (fly ash+RBI-81) based on strength & improvement criteria.

REFERENCES


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CONSTRUCTION OF WATER STORAGE TANK BELOW THE GROUND BY USING FERROCEMENT (May 2020)

Tanmay Gothankar, Saurabh Jadhav, Pravin Rane, Darshan Gaikwad.
(B.E. Civil Engg. Students, Gharda Institute Technology, Lavel, Mumbai university)
Under the guidance of Prof. G. D. Parulekar
(Department of Civil Engineering Gharda institute technology, Lavel)

ABSTRACT Ferrocement construction technology is quite popular throughout the world. Ferrocement, a thin element, is used as a building construction as well as a repair material. The project attempts to review the literature on ferrocement and bring out the salient features of construction, material properties and the special techniques of applying cement mortar on to the reinforcing mesh for the construction of ferrocement water storage tank below ground. The study brings out the importance of using ferrocement in water retaining structures like swimming pools and water tanks, and also in the repair of old/ deteriorated ferrocement structures. The recommendations of this study include the use of ferrocement for water retaining structures below ground to overcome water requirements in drought prone areas. The experimental investigation may be conducted on new reinforcing materials by researchers in the future. The study concludes that ferrocement will certainly be one of the best structural alternatives for RCC in the future and can be adopted for construction of economical water storage tank.

INDEX TERMS Ferrocement; Mortar; Construction; Reinforcing mesh; RCC.

➢ INTRODUCTION

Ferrocement construction technology is quite popular throughout the world. Ferrocement, a thin element, is used as a building construction as well as a repair material. This paper attempts to review the literature on ferrocement and bring out the salient features of construction, material properties and the special techniques of applying cement mortar on to the reinforcing mesh.

This study brings out the importance of using ferrocement in swimming pools and water tanks, silos, corrugated roofs, shell and dome structures and also in the repair of old/ deteriorated RCC structures. Also is discussed in this paper a the use of supplementary cementious material like fly ash as the partial replacement to the cement.

The recommendations of this study include addition of fibers in ferrocement to reduce crack-width. The present authors recommend that experimental investigation may be conducted on new reinforcing materials and addition of various supplementary cementious material to compare the cost of tank by researchers in the future.

Ferrocement construction

Ferrocement can be considered a type of thin reinforced concrete construction in which large amounts of small-diameter wire meshes are used uniformly throughout the cross section instead of discretely placed reinforcing bars and in which behavior cement mortar is used instead of concrete. Metallic mesh is the most common type of reinforcement. Meshes made of alkali-resistant glass fibers, and woven fabric made of vegetable fibers such as jute-burlap and bamboo, have also been tried as reinforcement.

➢ MATERIALS:
The Following Materials Are Used In This Work:
1) Ordinary Portland Cement (53Grade)
2) Crush sand
3) Wiremesh
4) Water
5) BindingWire
6) Admixtures

5. **Cement**: Ordinary Portland cement can be used. Cement is a building material cement is the product obtained by burning a well-proportioned mixture of siliceous. The ordinary cement we commonly use is known as Portland Cement it is greyish green in colour. Initial setting time of cement is 30mm and final Setting time is 600 min (10hrs).

6. **Crush sand**: The source of Crushed sand is a quarry. It is manufactured by Crushing rocks, quarry stones or larger aggregate pieces into sand size particles in a factory or quarry. The shape of Crushed sand is cubical and angular and has a rough texture and hence better for concrete. The compressive strength as well as the flexural strength of concrete made from Crushed sand are higher than natural sand.

7. **Wire Mesh**: Ferrocement uses layers of continuous / small diameter steel wire / weld mesh netting as reinforcement with high volume fraction of reinforcement and the specific surface of reinforcement is considerably higher for ferrocement than for RCC. Also, the reinforcing steel wire mesh has openings large enough for adequate bonding; the closer distribution and uniform dispersion of reinforcement, transform the otherwise brittle mortar into a high performance material distinctly different from reinforced concrete. Skeletal steel rods/wires/strands are used as spacer material and to form the skeleton of the shape of the structure to be built, around which the mesh layers are later attached. We have use wiremesh having 4 feet height and with spacing 1 cm/c.

8. **Water**: Portable drinking water was used for mixing and as well as for curing other constituent elements.

9. **Admixtures**: For the increasing the workability, minimizing water use and reducing the setting time of cement admixture are added.

---

**Equipments Required ferrocement Construction**

- 10. Nails
- 11. Plumb Bob
- 12. M.S.Plane
- 13. SteelCutter
- 14. Chisel
- 15. WireBrush
- 16. Spade
- 17. Showel
- 18. Sieve
- 19. WheelBarrow

---

**METHODOLOGY**

The Ferrocement Construction Is Done In Four Parts As Belows

- a. Excavation
- b. Pccwork
- c. Fixing of Reinforcing mesh
- d. Preparing TheMortar
- e. Applying Mortar
- f. Curing.

29) **Excavation**: According to the layout of the project the excavation were done manually. The trapezoidal pit was excavated with dimensions by considering the both layers of mortar as well as PCC work.

---

30) **Pccwork**: The plane cement concrete is used as a base layer which will resist the water force and transfer it to the soil strata. For the PCC work the concrete with the M10 grade were adopted. The thickness of the PCC was 75 mm which is sufficient. According to the ferrocement society of India the generally 50 mm to 80 mm thickness is adopted for the ferrocement works.
31) Fixing of Reinforcing mesh

It ferrocement below ground water storage tank the wire mesh is used as a reinforcement in stead of the steel reinforcement. The wire mesh were laid on the PCC work by keeping the clear cover of 15 mm between the wire mesh and PCC. The 15 mm cover blocks were constructed for placing between them. The wire mesh were fixed with the help of the binding wire and concretenails.

32) Preparing The Mortar

The material required for the construction like cement, aggregate, fly ash, crush sand were mixed manually near the construction site. For the PCC work M10 grade of concrete was used and for mixing the mortar 1:4 proportion of mortar is considered with 10% of fly ash as a supplementary cementitious materials to reduce the cost of project.

33) Applying Mortar

The mortar were applied over the PCC work so that the wire mesh must be covered with the cover of 15mm thick layer of mortar. the amount of the water proofing agent were also mixed with mortar for in hancing water retaining water retaining capacity of tank. For getting good finishing and enhance the water retaining capacity of the ferrocement water storage tank below ground the thick layer of water proofing agent were applied over the surface of them mortar.

34) Curing

Curing is very important for ferrocement work. the curing for the completed ferrocement work to be done after 24 hours. The curing to completed work to be done for minimum 14 days and maximum up to 21 days. we have used rice straw for curing.

ESTIMATE AND DESIGN OF TANK

Where,

Top side length = 2.5 m Bottom side length =1.2 m Height of tank = 0.7m

Area of top side = L X L

= 2.5 m X 2.5 m A₁ = 6.25 m²

Area of bottom side = b x b

= 1.2 m x 1.2 m

A₂ = 1.44 m²
Average Area of tank = \( \frac{A_1 + A_2}{2} \)
\[ = \frac{6.25 + 1.44}{2} \]
\[ = 3.845 \text{ m}^2 \]

Volume of tank = Area x Height
\[ = 3.845 \times 0.7 \]
\[ = 2.691 \text{ m}^3 \]

Hence, capacity of tank = 2691 litre.

**Total Quantity Required**

<table>
<thead>
<tr>
<th>Sr. No</th>
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<th>Unit</th>
<th>Quantity</th>
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<tr>
<td>1</td>
<td>Cement</td>
<td>Bag</td>
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<tr>
<td>2</td>
<td>Crush sand</td>
<td>Cu.m</td>
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</tr>
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<td>3</td>
<td>Aggregate</td>
<td>Cu.m</td>
<td>0.372</td>
</tr>
<tr>
<td>4</td>
<td>Water</td>
<td>lit</td>
<td>124</td>
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<tr>
<td>5</td>
<td>Fly Ash</td>
<td>kg</td>
<td>28</td>
</tr>
<tr>
<td>6</td>
<td>Wire mesh</td>
<td>Sq. ft</td>
<td>136</td>
</tr>
</tbody>
</table>

**Cost of Tank:**

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<th>Sr. No</th>
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<th>Unit</th>
<th>Quantity</th>
<th>Rate</th>
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<tr>
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<td>435</td>
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<tr>
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<td>Wire mesh</td>
<td>Sq. ft</td>
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<td>18/sq.</td>
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<tr>
<td>5</td>
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<td>1</td>
<td>160</td>
<td>160</td>
</tr>
<tr>
<td>6</td>
<td>Fly Ash</td>
<td>kg</td>
<td>28</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Binding wire</td>
<td>kg</td>
<td>1</td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>

**Total** | **6043**

- Suitability for pre-casting.

**REPAIR AND MAINTAINCE**

For ferrocement construction maintenance is very less, but due to heat and some mistakes remains there is a chance of developing minor cracks in ferrocement work but such small cracks will not affect the workability of ferrocement, but if the cracks are bigger then repair is required. Care is required to be taken for the ferrocement work to be workable. Proper curing of the completed work is essential for 21 days also it is to be kept safe from impact and extremes sunlight.

**USES OF FERROCEMENT**

- Boat
- Water tank
- OF Toilets
- Kitchen Otta
- Biogas Plant
- Roof Houses
- Geodesic Dome
- Low Cost Dwelling House
- Strengthening Reinforced Concrete Element
- Strengthening Masonry Element
- Marine
- Agricultural
- Tank Container & Silos
- Floor & Roof

**ADVANTAGES**

- Basic raw material readily available
- Ease of construction, low weight and long life time.
- Better resistance against earthquake.
- Heavy plants and machinery are not required.
- 20% saving on material and cost.
- Low maintenance cost.

**PRIMARY DATA COLLECTION**

A complete report based on the survey at Pen organized by Gharda Institute Of Technology for B.E Civil engineering students, in order to enhance practical knowledge and to collect the necessary primary data about the actual construction procedure, its requirements, to cater the need of construction.

For the collection of primary data we had conducted a survey at Vadav village in Pen on 01 February 2020, under the guidance of prof. G.D. Parulekar sir and prof. V. S. JadHAV sir.

A. **Overview of the place**

The area is situated near the coastal (bay) region. Due
to this there is availability of salty water is more, resulting the scarcity of drinking water. There are many pond prepared near each houses which are used to store the water during the rainy season. In this area these water stored in the pond is used for the daily household need like bathing, washing cloth etc. as there is scarcity of drinking water, the drinking water is collected from a well present 4 km away from the village residence.

Due to this hesitating process for collection of drinking water, the villagers decided to overcome the situation of scarcity of drinking water the ferrocement tank were constructed under the “Shivkalin Panipuravtha Yojana”.

150 tanks were constructed in the area in year 2002-03.

B. Material used for tank

The ferrocement water storage tank were constructed with locally available materials to reduce the cost of construction. The material used for ferrocement tank construction are cement, sand, aggregate, and 8 mm dia. Steel. they had also used murrum, lime powder, and boulders for foundation purpose.

C. Characteristic of construction tank

• The constructed ferrocement tank are having the 10000 litre capacity.
• The overall dimension of the tank are of 5 feet depth with diameter of 10 feet.
• The cost which the villagers had to be was 15000 RS from which tank owners had 10% contribution.
• For the covering the upper face of the tank the slab were constructed, some tank had used precasted slab.

D. Water collection oftank

• The refilling of the tank is done with the help of Rainwater Harvesting Technique. During the rainy season the tank is filled with rainwater. The screening of rainwater is done for avoiding any impurity entering into the tank.
• The outlet is provided at the bottom of the tank to collect the water from the tank for drinking purpose.
• The chlorine is used as a disinfectant to treat the drinking water.

E. Maintainance of the tank

The yearly maintenance of the tank were done by the villagers. There were no major problem to most of tanks, for some tanks there are minor cracks on the outer surface of the tank. The crack can be reduced by applying the paint on the tank surface.

F. Conclusion

• Using the primary data collection method of survey we had collected the information about the constructed ferrocement water storagetank.
• The survey help us to understand the construction method and processes for the ferrocement construction techniques.
• The problems for constructed tank were observed and analysed in this survey.
• The survey finding are helpful for us for the construction of underground ferrocement tank, to reduce the construction cost and to make it more durable.

Examined the tank

Checking quality of water

➢ FUTURESCOPE

1) The experimental investigation may be conducted on the addition of fibres to the mortar to increase strength offerrocement.
2) The variety of reinforcing material can be use with the adaptation of various supplementary cementious materials to compare there result

➢ CONCLUSION

• Ferrocement being a labour intensive and a material saving technique, has never been able to complete with reinforced cement concrete. However, innovative structures in different part of the world have clearly indicated the unique, unmatched properties of this material.
• The ferrocement is the technique in which the cement mortar and steel wire mesh is used as reinforcement instead of the use of conventional steel bars and concrete. The ferrocement provides excellent tensile and flexural behaviour to the structure. The ferrocement is the ductile material where as the conventional concrete is ductile material.
• The ferrocement constructions are economical having high earthquake and fire resistant structures which is proven analytically and experimentally during earthquake. The ferrocement structure is light but strong and durable with a weight reduction to almost 1/10th of the conventional material.

• The paper is based on the construction of the water storage tank below ground using ferrocement technique. Such tanks were beneficial for the drought prone areas where there is huge scarcity of water and less water storing capacity.

• From the paper it is concluded that the ferrocement technique is effective for the construction of the water storage tank below ground. The locally available materials can be utilized for the economical construction using ferrocement technique. It also shows the use of fly ash as supplementary cementitious material.

➢ REFERENCES


• Mohit Talwar, et.al, International Journal of Advanced Research in Computer Science vol.08,no.04 May 2017

• S.Sekar, et.al, Experimental Behaviour on Ferrocement Circular Water Tank by Using Chain Mesh,vol 05,(2018)


➢ LINKS

1) http://jalshakti-dowr.gov.in/evaporation
2) http://www.engineeredcomposites.com/Applications/mitaka_dam.html
ABSTRACT
We all understand that global warming is a phenomenon that bears a deeply negative impact on the nature. Global warming mainly happens due to emission on greenhouse gases, once these gases enter the atmosphere they cause a significant rise in the temperature, one of the most commonly emitted green house gas is CO₂ that is been observed to have caused a lot of climatic changes. Thus in order to reduce CO₂ emission we must provide a sustainable alternative to regularly used cement which is alone almost 8% of the global emission of CO₂. Here we explain a few alternatives like Green concrete, Bio Concrete etc. These will not only aid us to help overcome and manage the CO₂ emissions but would also have a significant impact the construction industry to become greener. Alongside with many economic as well as environmental benefits of the same that we will be able to avail.

INDEX TERMS Green Concrete, Bio Concrete, CO₂ Emissions

[1] INTRODUCTION
In fast growing world number of infrastructures increases tremendously this vigorous construction of buildings not only increases ppm in atmosphere but also concentration of. It is seen that about 8% of global atmospheric CO₂ emitted by concrete. Demolition of structure also leads to emission of CO₂. This all start with production of cement with heating of limestone which required lots of fossil fuel which emits CO₂. It is found that 1 ton of cement produce 0.9 tons of CO₂ and continuous till settling of concrete which includes large heat, transportation of concrete and chemical reaction happens during we add water into cement till it sets and reaches to final settling time. The CO₂ emission by cement concrete globally is more than CO₂ emission of planes, cargo ships and heavy trucks together 6%.

Fig 1: Construction of Bhurj Khalifa

Almost one tonne per person. For new construction of facilities, comforts and development infrastructure is needed that too with quality material having durability, strength and effective cost and all these qualities are satisfied by concrete and it leads to tremendous use of concrete which causes emission of concrete. These emissions are equivalent to 8% of global emission of CO₂ and this is more than aviation industry which accounts for about 2.5% and is not far behind the global agriculture business which is about 12%. Following graph shows global cement production has risen sharply, but appears to have leveled off. Due to the vast use and continuous production there is very less research done because we cannot find ingredient possessing similar properties like strength, durability etc. but now there are a lots of alternatives coming up some of them currently under research some of which already in use in markets which would help us reduces the CO₂ emission.

Fig 2: Workers while casting of slab human

CURRENT SCENARIO
Concrete is second most used material after water by human being. Concrete consumption of our world is
In this reaction when limestone breaks down into CaO and CO₂. To overcome this problem alternatives are used earlier some of which reduce the amount of limestone by adding silica fume, fly ash, slag and some materials which totally displace limestone which are magnesium based but these alternatives are expensive, less durable or chemically unstable in spite of this research has been done which includes green cement, New cement, etc.

[3] ALTERNATIVES

3.1. FUEL SOURCE

Currently for clinker production raw material is used like local fuel, natural gases, or fuel oil which leads to excessive CO₂ emission instead of this use of renewable energy sources can be used. The trend of utilizing alternative fuel sources started in mid 1980s. fuels like biomass can effectively reduce the CO₂ emission by 20-25% compared to coal. Alternative fuel used by industries are mainly lumpy material, waste tires, plastic, paper residue, sewage sludge, animal residue, textile waste etc. results in low CO₂ emission.

3.2. BINDING SUBSTANCES

Due to fundamental chemistry traditional Portland cement production continues CO₂ emission so alternative cement and binding technologies go beyond evolutionary CO₂ capture to revolutionary method that fundamentally sequester CO₂. Action and the possible impact on cement-related CO₂. It is the idea which includes raw material other than the limestone for production of clinker which can reduce the CO₂ emission materials like slag, blast furnace slag, metakaolin, fly ash kaolinitic clays, and red mud can be used. Alkali activated cements are good competitor to the Portland cement in cost performance and less CO₂ emission. Also they proved to have more durability and ability to recycle the millions of tonnes of industrial byproducts and waste. Based upon the composition of cementitious components, alkali-activated cements are classified into five major categories.

1) alkali-activated slag-based cement
2) alkali-activated pozzolan cement
3) alkali-activated lime-pozzolan/ slag cements
4) alkali-activated calcium aluminate blended cement
5) alkali-activated Portland blended cements

<table>
<thead>
<tr>
<th>Action / Process</th>
<th>% reduction in CO₂ emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon capture and storage</td>
<td>95-100%</td>
</tr>
<tr>
<td>Novel cements</td>
<td>95-100%</td>
</tr>
<tr>
<td>Clinker substitution</td>
<td>70-90%</td>
</tr>
<tr>
<td>Alternative fuels</td>
<td>40%</td>
</tr>
<tr>
<td>Energy efficiency</td>
<td>4-8 %</td>
</tr>
</tbody>
</table>

Table 1: Achievable % reduction in CO₂ emission

4. ADVANCED TECHNOLOGIES

4.1 BIO CEMENT

Ginger Krige Dosier, co-founder and CEO of BioMason- a startup in North Carolina that uses trillions
of bacteria to grow bio-concrete bricks. The technique which involves placing sand in moulds and injecting it with microorganisms, initiates to the one of that creates coral. They have long fascination with marine cements and structures. Ms. Krieg Dosier work on this for 10 year. The discovery led her to create her own solution, which, after years of development, now takes only four days. It happens at room temperature, without the need for fossil fuels or calcination which are the main two source of cement manufacture, patented by different manufacturing agencies.

[4] CONCLUSION
Taking into consideration several researches it is observed that sustainable concrete is the need of time. It is seen that globally we built new infrastructure equivalent to big as New- York city every month and it produces tremendous CO₂ emission but by following above alternatives we can handle it efficiently. Improvements in the energy efficiency of new plants and burning of waste materials instead of fossil fuels has seen average CO₂ emission per tonne output fall by 18% over the last few decades. The newly established global cement and concrete association (GCCA), currently representing about 35% of the worlds cement production capacity and with focus on sustainable development. For need of future generation by providing focus and detailed work programme we can ensure sustainable future. And for this awareness among industries, research and government support with funding and regulations we can achieve the goal very soon.

ACKNOWLEDGMENT
We are humbled to be able to present this research to you which would not have been possible without the help of our families, Dr. Akshay Thorvat HoD Dept of Environmental Engineering, KIT’s College of Engineering, (Autonomous) Kolhapur for their cooperation, support and guidance towards our work and for the immense encouragement. We also extended our thanks to publishing team for providing us with a platform to showcase this research.

REFERENCES

SHUBHAM D JOGDAND has completed Diploma in Civil Engineering from Yashvantrao Chavan Institute of Polytechnic, Beed in year 2018. As a part of final year research he researched on Hydraulic Bridge Model with possible application for control of waterways traffic and currently pursuing Graduation from KIT’s
College of Engineering in Environmental Engineering. He has coauthored a paper presented “Solid Waste Management Plan Of Mahalakshmi Temple Kolhapur” in an International Conference on Sustainable Development Goals for 21st Century organized by Chhatrapati Shahu Institute of Business Education and Research (CISBER), Kolhapur and Maharashtra Pollution Control Board.

POOJA A. YAKANALLI has completed Diploma in Construction Technology from Vidyavardhini’s Bhausaheb Vartak Polytechnic, Vasai in year 2018. Has presented papers on Advanced Construction Technique used to build Ice Hotels and worked on a research Comparison of Bitumenous Road VS Cement Concrete Road, Green Buildings and also coauthored a paper presented “Solid Waste Management Plan Of Mahalakshmi Temple Kolhapur” in an International Conference on Sustainable Development Goals for 21st Century organized by Chhatrapati Shahu Institute of Business Education and Research (CISBER), Kolhapur and Maharashtra Pollution Control Board.
SOLID WASTE MANAGEMENT PRACTICES OF STREET FOOD VENDORS (CASE STUDY OF RANKALA LAKE KOLHAPUR)

1Saurabh S. Gaikwad, 2Gajala I. Apradh, 3Rugved K. Kulkarni, 4Prajwal M. More, 5Manjussa N. Sarnobbat

1 Research Student, 2 Research Student, 3 Research Student, 4 Research Student, 5 Assistant Professor
Department of Environmental Engineering, KIT’s College of Engineering, Kolhapur

ABSTRACT
This study is intended to determine the solid waste management practices of street food vendors at rankala lake, kolhapur. The study used the descriptive methods like surveying and purposive sampling technique. There are around 70-75 street food vendors across consisting of veg and nonveg food items. Rankala is one of the tourist place attracting nearly 1500 visitors every day. In this method four samples were collected from different street food vendors at an interval of one week to study the waste composition. After that the segregation of waste is done at experimentation point and corresponding weights are taken. The waste generated here mostly consist of organic wastes, paper and plastics. Individual containers were utilized for collection of waste and later dumped in community bins provided by KMC (Kolhapur Municipal Corporation). The street food vendors were dependent to the KMC for their solid waste disposal. Waste segregation at source is not practiced mostly. Based on the survey and experimentation some suggestions are given to segregate the waste at source, composting of organic waste and recycling of paper and plastic waste. Strict legislation should be imposed for those who does not follow rules and guidelines.

INDEX TERMS
Solid Waste, Street Food Vendors, Waste Management, Rankala, Disposal Practices, Segregation, Coning and Quartering Method, Composting.

INTRODUCTION
Kolhapur district is the southernmost district of Maharashtra. Its headquarter is Kolhapur City which is an ancient city. The city is situated on the banks of river Panchganga and is known as ‘Dakshin Kashi’. Kolhapur is seat of Goddess Mahalakshmi and is one of the Shaktipeeths mentioned in Indian mythology.

According to 2011 census data, the total population of Kolhapur city is 5.5 Lakhs and today daily waste generation is 200 tons per day.

The problem of solid waste management in this contemporary world is ever increasing. Same is the case with the urban city, Kolhapur. Like every other environmental engineer aspires, the main aim is management and disposal of waste without disturbing the ecology and the environment. Waste management involves the collection, transportation, processing, recycling or disposal and monitoring of waste materials. But what serves as a challenge for treating waste from the residential areas of Kolhapur, is the lack of implementation of waste segregation and awareness of problems faced due to not practicing it.

Street vendors also known as hawkers, roadside vendors include all those who sell ready-to-eat or prepared-on-demand food in public spaces such as sidewalks, street corners, or in regulated spaces such as tourist places. The vendors may have pushcarts which are wheeled into their sales position daily, or they may go through the streets on foot, by bicycle, motorbikes, or wheeled pushcarts.

Street food is an integral part of the food culture in Kolhapur. It is popular among locals because it is accessible, convenient, and cheap. Many people on the other hand, have been attracted to engage in street food vending because it provides a good source of income for them, is easy to put up, and does not require business permits. However, wastes generated from these food stalls are a major cause of litter strewn in the streets. If not managed properly, it is not only aesthetically offensive but it also poses risks to public health and clean-up can be costly. Moreover, litter from these sources easily end up in sewers which can lead to clogging of drainage systems. Figure no. 1 shows the beautiful view of Rankala Lake, Kolhapur.

Fig. 1Rankala Lake, Kolhapur
There is a need for reviewing the current Solid Waste Management practices in this sector in order to recognize the good practices, to identify the opportunities of waste reduction and of turning waste to resources. It also helps in determining the challenges and issues on the current system so they can be addressed properly and the whole system be made more efficient and sustainable even when volumes of waste expand. The study in the area can serve as a model for other street food vendors. It has applications in strengthening policies for the improvement of SWM in the street food sector. Figure no. 2 shows the street food vendors at Rankala Lake, Kolhapur.

(7) Problem Statement
The study is aimed to determine waste management practices of street food vendors at Rankala Lake, Kolhapur, Maharashtra.

This study is done to answer the questions as following:
1. What is the composition of waste generated at determined places?
2. What are the waste storage practices among the vendors and what facilities are available?
3. What are the waste storage practices among the vendors and what facilities are available?
4. What are the waste storage practices among the vendors and what facilities are available?
5. What are the waste disposal practices adopted by the street vendors and the municipal corporation?
6. What measures are adopted by municipal corporation to reduce the waste generated?

Fig 2. Street vendors at Rankala Lake

(8) Significance Of Research Work:
20. Research work will help in analysing various problems, difficulties, challenges faced by street food vendors at Rankala, regarding the waste management.
21. It helps in suggesting, designing new and effective solutions.
22. Before suggesting any solution/method for management of this waste it is important to know exact composition of the waste or variations in waste with respect to time and season, hence it is important to collect & investigate this waste in proper way, the project work will help us to do that.
23. It gives background for further studies and research work.

(9) Objectives:
35) To study the composition of solid waste produce by street food vendors at Rankala (Kolhapur) and its effective waste management.
36) To study various methods adopted at various levels in order to manage solid waste at its place of generation.
37) To suggest methodologies for the sustainable management of solid waste produced by street food vendors.

– METHODOLOGY
F. Data gathering
Data gathering is done by surveying and interviewing with the street vendors. The questionnaire prepared based on section line: Type and composition of solid waste generated, storage practices and disposal of waste generated.

G. Study Area
Rankala Lake is on the western side of Ambabai temple, it is a popular evening spot and recreation centre. This lake was constructed by late Maharajah, Shri Shahu Chhatrapati. The Lake is surrounded by Chaupati and other gardens. In the backdrop stands majestic Shalini Palace. Chaupati also brings memories of Chatak daar Bhel-Puri and Ragda-Patties and variety of food snacks. Figure no. 3 shows the Rankala Lake topographic map, elevation. Coordinates 16.6905° N, 74.2106° E. Minimum elevation 538 m, Maximum elevation 674 m, Average elevation 573 m.

Fig3. Location of Rankala Lake, Kolhapur

Rankala is one of the tourist place attracting nearly 1500 visitors every day. There are around 70-75 street food vendors spread across 3-4 chaupaties i.e. in small pockets. Only 5-6 nonveg vendors are there. These eateries start around 5 in the evening. Every day on an average 100 plates are served by each of the vendor. During festive season, number of pilgrims visit Kolhapur city and hence come to Rankala for sightseeing that’s why major sells
happens during festivals. Tourist enjoy the lake view while eating mouth-watering food. But during rainy season, number of tourists reduce drastically and thus resulting in very less sells.

The waste generated here usually consists of organic waste, paper and plastic. Rankala is being one of the most recognised tourist place, it is at most essential that the waste generate here is managed by KMC (Kolhapur Municipal Corporation). Figure no. 4 shows the common bins at Rankala Lake. The waste generated by vendors is collected by individual or common bins and later before closing the stall they throw this waste in community bins which are provided in three spots. Segregation of waste is not done by them. In night around 10 pm for transportation of this waste to dumping site, a RC vehicle or tractor is provided by KMC. Figure no. 5 shows the community bins provided by KMC.

Various collection points around the lake were identified. Some of the identified collection points were private and common dustbins of vendors and public bins provided by KMC.

The samples were collected for 4 times within time difference of 1-2 weeks between them. Samples were taken from different places and it was taken care that all the identified sources were covered. In collection of sample the safety was given prime importance so various safety instruments like gloves and mask were used.

The collected sample was then taken in Laboratories for the weight measurement. Figure no. 6 shows the process of measurement of waste done. Measurement was done by using coning and sampling method that is the sample size was reduced without creating a systematic bias and then the total weight of the sample obtained was calculated.

Once the total weight of sample is known the composition of the waste was found out, for this the sample was segregated and each component was weighted separately with the help of balance and then the percent of each constituent compound was noted. Figure no. 7 and 8 shows the segregation of waste and composition of waste.

We selected this area in order to recognise the composition of waste produced by street food vendors at Rankala and suggest methods for its efficient management.

**H. Experimentation**

6) Sample collection:
Moisture Content:

Moisture content is a typical determinant in economic feasibility of waste treatment, by incineration. Moisture content also plays an important role in other processing methods too, like composting anaerobic digestion. The optimum moisture content for composting is 50-60%.

Once the sampling was done, 200g of waste needs to be taken for measurement of the moisture content of the sample. Figure no. 9 shows the measurement of weight for moisture content. Firstly, the weight of the crucible was taken. Then, 200g of the selected sample was kept in the oven for 2 hours. Figure no. 10 shows the oven drying of the sample. After 2 hours, the weight of the sample was taken. The difference between the initial weight and the final weight will give us the moisture content in the sample.

RESULTS AND DISCUSSION

By using coning & quartering method, we have segregated the samples and the results are analysed. Here we are discussing the composition of our samples in detail:

Results Of Composition Study:

Table no. 1 shows the details of average readings of 4 samples. Figure no. 11 shows the pie chart of average readings of 4 samples.

Average reading of samples:

Table no 1

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Components</th>
<th>Percent by Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Organic Waste</td>
<td>70</td>
</tr>
<tr>
<td>2.</td>
<td>Paper</td>
<td>21</td>
</tr>
<tr>
<td>3.</td>
<td>Plastic</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

Average

Fig 8. Composition Of Waste

Fig 9. Measurement Of Weight For Moisture Content

Fig 10. Oven Drying For 2 Hours

Fig 11. Pie chart of average readings of samples
➢ Discussion:
From the above average readings of the waste composition, the major components of waste were organic waste, paper and plastic.

It has been found that around 70% of the waste was of organic form. It consists of peels of Onion, cucumber, carrots and cut pieces of tomatoes, coriander, pudina, cabbage. Also, it consisted of wet tea powder, chutney of panipuri left on plates, egg shells, pieces of chicken, left over of food stuff, etc.

Paper waste has contribution of about 21% to the total waste. It consisted of paper plates and newspaper pieces used for serving of food stuffs and packaging, butter paper, tissue paper, aluminium foil used for keeping food stuff warm, etc.

The plastic waste was about 9% of the total waste which was in the form of packaging, wrappers, packets, coverings used for breads, packaging of ice-cream cones, etc.

The possible solution for this waste management would be:
2. Segregation of the waste at the source itself
3. Composting of the organic waste (Figure no. 12 shows the composting of an organic waste done at source)
4. Recycling of paper and plastic waste
5. Suggesting composting bins at Rankala

In this case if composting is to be done, then the moisture content can be increased by adding water to the waste sample.

➢ Discussion Of Moisture Content:
When the moisture content is high, anaerobic conditions set in. The composting mass should have a certain minimum moisture content in it for the organisms to survive. The optimum moisture content is in between 50-60%.

It is found that the moisture content in our samples is around 15%. It is lower because the waste sample was consisting of peels of onion, cucumber, carrots and the cut pieces of tomato, cabbage, coriander, etc. These components were stale and slack and moisture was reduced due to being thrown in bins for a long time.

Since the waste sample consists of more of the organic matter, composting can be done as a solution. For increasing the moisture content up to desired limit, water can be added to the sample. It would be done by using either Bangalore method, Indore method or windrow composting.

Also, if moisture content is desirable, we can go for anaerobic digestion (Biogas). Figure no. 13 shows the biogas plant.

CONCLUSION
From the study carried out in present work, following are the findings and conclusions:-
3) Proper segregation of waste at the source is necessary, segregation of waste should be done at source only.
4) Organic waste has been found to be around 70% in case of street food vendors.
5) Dry waste and Wet waste should be collected separately. KMC should provide separate bins in this regard.
6) The organic waste can be collected separately and a collective compost plant can be installed in the same region whose by-product after composting can be used as a manure at Rankala Garden.

7) Paper and plastic waste was found around 30% which can be recycled by collecting separately.

8) Dumping of waste by roadside and in peripheral area should be avoided and strict action should be taken on such practice.

9) Better management of street food vendor’s organic waste can help to reduce the waste dumping by 60-75%.

10) Strict legislation should be imposed for those who does not follow rules and guidelines.

REFERENCES


13) Municipal Solid Waste Management Manual (CPHCEO),2014

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Physical Model Studies Of A Bridge Across River Hindon: A Research.

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ABSTRACT

The hydrological model is prepared to predict the most possible effects on the channel. Effect such as change in river bed, morphology topology. There are two types of models physical model and mathematical model. These models are used to know the highest flood level, to get idea about the flood prone areas. This study is carried to fix the safe deck level, afflux, waterway and scouring effect after construction of RRTS bridge. It is observed by studying various researches that physical model gives compatible results with actual site conditions. By using actual site data which is converted into a suitable scale & physical model is prepared. If the model is prepared without changing actual site data it will give the correct readings. This paper discusses the details of the model studies for proposed bridge across river Hindon connecting Delhi-Ghaziabad-Meerut RRTS corridor which is being taken up for implementation by NCRTC.

INDEX TERMS

RRTS, Morphology, safe deck level, NCRTC, flood level, waterway, scour, afflux etc.

INTRODUCTION

River Hindon, a tributary of river Yamuna, is entirely reinfed with a catchment area of 7038 sq.km. It flows between Ganga and Yamuna for 400 km through Muzaffar Nagar, Ghaziabad and Noida before joining river Yamuna just outside Delhi. A river composed of main course and the tributaries which brings substantial contents in the form of dissolved particles and minute separate particles from both natural and anthropogenic sources. Flood constitute one of the critical problems and the problem is gigantic and becomes more complicated with the passage of time[4]. The flood in 1998 sever flood is the highest record. The value of travel time of flood wave from base station to forecasting station according to historical method is 2 days[4]. In this paper, unfortunately, river play major role in transportation and accommodation of industrial waste water and runoff from agricultural lands and most of times serves as a place for disposal of sewage[2]. In this paper Physical model study is carried out on Hindon river model covering a reach from 8 km upstream to 2 km downstream of bridge connecting Dilshad Garden to New bus adda in Ghaziabad. This study is carried out for construction of RRTS bridge for Northern Railway. In this regard National Capital Region Transport Corporation (NCRTC) has approached Central Water And Power Research Station (CWPRS), Pune for the conduct of Physical model studies to assess the hydraulic parameters of proposed bridge. NCRTC is a government of India enterprise body and this body is responsible for construction of railway bridges in northern areas for facilitating fast and rapid transport of railway corridors. The NOIDA, part of NCT has proposed to road bridges across river Yamuna, one connecting Ghaziabad-Noida-Faridabad passing through sectors 167A-168 and another one passing through sectors 149A-150 to improve the traffic movement from Noida, UP to Haryana[1]. The functional plan on transport for NCR-2032 recommended connecting Delhi with various nodal towns in NCR through 8 Region Rapid Transit System Corridors. It has 8 corridors out of which 3 corridors are passing through Delhi-Ghaziabad-Meerut RRTS. Regional Rapid Transit System (RRTS) being a high-speed, high capacity rail based commuter Transit System. It will drastically reduce the travel time between various nodes of NCR served by it. Such transport solution will support the goal of sustainable economic and social development of the region, with protection of environment. This paper discusses the details of the model studies for proposed bridge across river Hindon connecting Delhi-Ghaziabad-Meerut RRTS corridor which is being taken up for implementation by NCRTC.

Figure1. Auto-Cad drawing of proposed RRTS bridge.
2. LITERATURE STUDY

2.1 Studies for locating a road bridge on river Yamuna in Meandering reach at New Delhi – A case Study. (S.S.Kerimani, Jotsana Ambekar, S.P.Hedaoo, R.G.Patil)

In this paper the author state that, they have taken three different discharge conditions 7,022 m³/s (which was recorded as maximum discharge in 1988 at Wazirabad Barrage), 9,910 m³/s (design discharge considered for ISBT bridge and bridge proposed subsequently on Yamuna ), 12,750 m³/s (check flood for substructures, foundation and protection works suggested by central water commission) for the construction of a bridge across Yamuna. For model preparation and their methodology and also to study maximum water level, velocity and discharge intensity under existing condition with straight guide bund we have referred this

2.2 Hydraullic modelling of river flow-data collection and problem solving (Ronny Verhoeven, Robert Banasiak, Jaroslav Chormanski)

In this paper the study of discrepancy between theoretical solution of the Saint-Venant equations for flood routing calculations and the problems caused during practical implementation is often quite big. The equations used for steady and unsteady flow simulation, topographical and hydraulic collection of data, longitudinal profile and friction coefficient, etc. are referred from this paper.

2.3 Hydraullic model of river flow and storage effects in the Mackenzie Delta,Canada (Jennifer Nafziger, Faye Hicks, Rohyn Andrishak, Philip Marsh)

This paper reports on the application of hydrodynamic model and development of the same model of river flows and off-channel storage effects on the Mackenzie Delta, Canada. To estimate reduced or increased ice jamming, how water levels through the delta changes with respect to change in river flows, increasing sea-level, various river flow and storage effects, etc are studied from this paper.

2.4 Hydraulic model studies for channelization of river Kosi for a reach model Chatra to Kosi barrage using Hockey stick shape spur (Sanjay A. Burele, Nayan Sharma, Z. Ahmad, I.D. Gupta)

This paper reports on the Channelization of stream to make it more suitable for navigation and to restrict the water to a certain width to reclaim lands for other various important purposes. Physical model studies are also conducted in this paper to investigate the various options for channelizing the stretch of river Kosi from Chatra to Kosi barrage. Analysis of mathematical model results for various waterways are presented in this paper. To study various model construction activity, design discharge, flow pattern studies, channelization studies (with construction), etc. this paper is referred.

3. MODEL STUDIES

By study of above literature research paper we found model setup procedure. By referring paper[1] the model studies were carried out for the three different discharge conditions on model of river Yamuna. The existing mobile bed model of river hindon at New Delhi Ghaziabad constructed to a horizontal scale (Lr) of 1:125 and Vertical Scale (Dr) of 1:30, covering a river reach of 8km upstream and 2km downstream from Dilshad Garden to New Bus adda in Ghaziabad. The model reach including deep channels, shoals, spill portion and various existing bridge structure, etc[1]. The survey data is given by NCRTC to CWPRS to reproduce proper bed movement and roughness, the model bed is laid with sand having mean diameter (D50) of 0.34 mm. The model discharge is measured using standing wave flume provided at the upstream inlet and is also verified at downstream of model. And it is done by using rectangular weir. Checking of flood for substructures, foundation and protection works suggested by the Central Water Commission. To achieve the proper many options of guide bund geometries were studied on the model for proper distribution of flow over entire width of water way. Water levels observed on the model at various gauge locations with the prototype values. Hydraulic design of bridge would be done based on experiment results.

3.1 STUDY AREA

River Hindon, a tributary of river Yamuna, is entirely rain fed with a catchment area of 7083 km. It flows between Ganges and Yamuna for 400 km through Muzaffar Nagar, Ghaziabad and Noida before joining river Yamuna just outside Delhi. The width of a river 20 m to 160 m covering a river reach from 8 km upstream and 2 km downstream.
That much read was provided and of which 8 km and 2 km was used and the other area does not affect the study so the 8 km upstream and 2 km downstream was utilized for model studies keeping view on site limitations.

3.2 STUDIES UNDER EXISTING CONDITIONS

Studies were initially carried out for the existing conditions of river without reproducing the RRTS Viaduct Bridge. The alignment of the RRTS Bridge was identified and marked on the model for reference purposes as per the drawing figures 4 experiments were carried out for four river discharges.

Independently after stabilizing the model bed by maintaining the established tail water level immediately upstream of Hindon barrage, velocity, depth of flow with river discharges of were measured at various locations, show the flow pattern near RRTS bridge at river discharges of respectivty. The flow conditions under existing conditions observed on the model indicate that the approach flow is concentrating on the left bank / left embankment/guide bund and is subjected to high velocity flow. The embankment guide bund toe near point A and portion of right guide bund under the bridges is under attack by the flow. Maximum water level, velocity and discharge intensity under existing condition with straight guide bund and elliptical guide bund at bridge axis.

3.3 STUDIES WITH RRTS BRIDGE IN POSITION.

The RRTS Bridge was reproduced on the model as per the layout and supplied by the project authority. Shows the model setup with RRTS Viaduct Bridge in position. Experiments were carried out for four discharges.

In each case after stabilizing the model bed by maintaining the established tail water level immediately upstream of Hindon Barrage. Water levels, were observed in the model at various locations by using gauges located upstream and downstream of the RRTS bridge. Maximum velocities, discharge intensities without and with RRTS bridge along with the afflux at the bridge are analyzed.

4. PROVING STUDY

The RRTS authorities have submitted a technical report of model studies conducted for the road bridge about 8 km upstream of the present bridge, the authorities have clearly indicated during the discussions that the observed gauge discharge data is not available. Hence, CWPRS was asked to adopt the water level Vs discharge variations given in the technical memorandum number 85RR(H2-02)titled “Hydraulic model study for road bridge over Hindon river at Ghaziabad by IRI, Roorkee. The data has been reproduced and observed water levels in the model for the given discharges at 700 m and 2100 m downstream of the said bridge is presented for comparison. It has been seen that by maintaining the water level at 2100 m downstream of the said bridge for given discharge, the water level observed on the model is consistently matching. Hence, the model is considered to be proved in such cases. While experiments were conducted for the proving studies, a gauge is established immediately upstream of Hindon Barrage. The readings of this gauge were established for maintaining the tail water levels later for conducting model studies without and with the proposed bridge.

<table>
<thead>
<tr>
<th>Discharges(Q)</th>
<th>Control guage to be maintained for resoective(Q) at 2100m chainage D/s of Loni Bridge</th>
<th>Observed gauge reading at 700m D/s of Loni Bypass bridge (cm)</th>
<th>Observed gauge reading at Hindon Barrage U/s of divide wall (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>920 cumec(1.58 cusec in model)</td>
<td>204.65</td>
<td>33.6</td>
<td>38.7</td>
</tr>
<tr>
<td>1840 cumec (3.165 cusec in model)</td>
<td>205.25</td>
<td>32</td>
<td>39</td>
</tr>
<tr>
<td>2760 cumec (4.75 cusec in model)</td>
<td>205.75</td>
<td>28</td>
<td>37.4</td>
</tr>
<tr>
<td>3681.20 cumec (5.33 cusec in model)</td>
<td>206.30</td>
<td>28</td>
<td>37.4</td>
</tr>
</tbody>
</table>

Table 2. Model Proving with Hindon river model scale (H-1:125, V-1:30)
5. GENERAL METHODOLOGY
By study of above literature papers we found general methodology for Physical model studies as below:
- Laying of model as per data available.
- Use of discharge scale.
- Alignment marking of model.
- Use of surveying methods and marking river boundaries.
- Use of tin sheets for marking river profile.
- Conducting model studies by taking various discharges.

5.1. METHODOLOGY FOR MODEL SETUP
Survey: As per available topo or cross-section data of river Hindon at CWPRS, we analyzed the data. In this river plan, proposed bridge details and other existing structural details are studied and reproduced.
Scale: Considering the site condition and using help of Auto-Cad based on the horizontal and vertical scale other hydraulic scales are need to be derived using dimensional analysis and model analysis techniques.
MODEL SCALE:
- Horizontal scale: - 1:125
- Vertical scale: - 1:30
As there is large variation in a horizontal and longitudinal basin so there is need of selecting different scale based on the variation
Discharge scale: \( Lr \times Dr \times \sqrt{Dr} \)
Velocity scale: \( Vr = \sqrt{Dr} \)

Bed Filling: To remove the unwanted undulations over the ground with help of filling and cutting of land profile
Excavation, laying concrete, murum, khaswa sand filling and river boundaries are marked.
The land profile is marked with the help of the Dumy level instrument and through the study the land filling and land cutting area is decided. The land is filled with stones and gravels.
Levelling: Levelling is a branch of surveying, the object of which is to establish or verify or measure geodetic height, and in construction to measure height differences of construction art facts. Instrument used like theodolite, levelling staff. River bed profile is marked by surface dressing to maintain given cross-section.

5.2. MODEL SETUP PREPARATION
Control gauge stations are marked as per actual site location.
Observation gauge stands are fixed near vicinity of proposed bridge.

Flow in the model is simulated with various discharge conditions.
All discharges are then maintained at standing wave flume with its corresponding head marking marked on flume.
Various hydraulic observations are taken.
Outcomings are analyzed and studied in graphical and statistical way.
Hydraulic design of bridge would be done based on experimental results.

5.3. EXPECTED RESULTS
1. The protective embankment in the upstream may be checked for any minor free board encroachment as mentioned above the top levels increased if necessary. Maximum velocities and discharge intensities under existing and after locating the RRTS bridge are presented. The maximum velocities and discharge intensities are found to marginally increase at bridge axis as a waterway is reduced due to provision of bridge piers. However, the bridge itself is not causing any major effect on the morphology of the river. The present bridge is not causing any major change in maximum velocities and discharge intensities existing near the downstream bridge.

2. The model studies indicated that the RRTS bridge would cause an afflux 6.9, 12 & 15 cm at RRTS bridge axis for the discharge of 920 m\(^3\)/s, 1,840 m\(^3\)/s, 2,760 m\(^3\)/s and 3,681.2 m\(^3\)/s respectively. The afflux is found to be negligible (not measurable) at a distance of about 0.6, 0.7, 1.02 and 1.4 km stream of the RRTS bridge axis for the respective discharges. The values of afflux are in normal range and will not cause any large scale difficulties on the upstream portion of river.

3. The RRTS bridge is constructed at about 30m upstream of the existing road bridge over Hindon river. The arrangements are provided in such a way that the piers of the RRTS bridge are aligned with the piers of downstream existing bridges because of the existing embankment on both sides of the bridge, the river is held between the fixed boundaries in this reach. Hence, there is no major morphological change expected in the reach of the river due to construction of RRTS bridge.

4. It is observed on the model with or without RRTS bridge that the flow is concentrating along the left guide bund /embankment and it is also showing tendencies to erode the right bank below the existing old and RRTS bridge. It is expected that the toe of embankment at those points will be subjected to very high erosion. The portion of embankments near these points should be monitored and if necessary protection works may be taken up on annual basis.
6. CONCLUSION

Based on the model studies carried out for various river discharges at CWPRS, using post-flood survey data, various recommendations will be made for hydraulic design of bridge for suitable orientation of bridge required for free and smooth condition. Based on the model studies carried out for various river discharges at CWPRS, using post-flood survey data, various recommendations will be made for hydraulic design of bridge for suitable orientation of bridge required for free and smooth condition and they are as below:

The alignment of RRTS bridge approximately 30m upstream of the existing road bridge does not cause any negative effect as far as river morphological behavior is concerned.

The alignment of RRTS bridge approximately 30m upstream of the existing bridge is found to be hydraulically satisfactory.

The toe of left embankment near a certain point extending up to the bridges and right embankment below the bridges are considered to be vulnerable to the erosion. Project authorities are advised to monitor these reaches and corrective measures in the form of direct bank protection works may be provided in case of any failure of existing protection works.

The foundations of the downstream bridges are advised to be monitored and necessary protection is to be provided, if necessary.

The afflux caused by the RRTS bridge is in the range of 6 to 15 cm for varying discharges. It is considered to be negligible and hence does not cause any effect under flow conditions of water and sediment through the bridge opening.

The existing upstream protective embankments may be checked for any minor free board encroachment and the top levels may be increased, if necessary.

The hydraulic model studies would be conducted to assess the rail bridge location, waterway and alignment. Water levels, afflux and velocity would be measured from the model for given discharges. Model will include given spill area along the stretch with details which affect the flow conditions in the river. Any other observations during the course of studies would be reported and any other suggestions would be given if necessary.

ACKNOWLEDGMENT

To put an effort like this requires the determination and help of many people around me and I would not be doing justice to their efforts by not mentioning each helping hand in person.

I feel privileged to acknowledge with deep sense of gratitude to my guide Prof. J.S. Gulvani & co-guide Mr. Shivandan S. Kerimani (Scientist ‘B’ CWPRS) and Project Co-ordinator Prof. K. H. Ghorpade for this valuable suggestion and guidance throughout my course of studies and help render to me for the completion of report.

I express my heart full gratitude to Prof. S.S. Deshmukh, Head of Civil Engineering Department, Prof. (Dr.) Nilesh J. Uke, Principal of College, and other staff members of civil engineering department for their kind Co-operation.

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7. REFERENCES


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FIRST A. SAMPADA MUKKAWAR. From kjei’s Trinity Academy Of Engineering,Pune. Final year Civil Engineering department and completed diploma from Dr. N. P. Hirani Institute,Pusad. Date of birth is 13 August 1998 and from Pusad,Dist.Yavatmal,Now pursuing Degree in Civil Engineering,Pune,Maharashtra state,India.

SECOND A. AJAY HINDULE From Kjei’s Trinity Academy Of Engineering,Pune (411048). Completed diploma from Government Polytechnic,Beed. Date of birth is 1 Feb 1997. Student of final year Civil Engineering Batch2020,Pune,Maharashtra state,India.


Use of Super Absorbent Polymer in concrete as an internal curing agent

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\(^2\)Department of Civil Engineering, MIT Academy of Engineering Pune Maharashtra 412105
\(^3\)Department of Civil Engineering, MIT Academy of Engineering Pune Maharashtra 412105
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ABSTRACT

This project is aimed to study the behaviour of super absorbent polymer as an internal curing agent in concrete and to reduce the consumption of portable water used in concrete for curing purposes as the whole world is struggling for water scarcity. It is study of how concrete will behave when external materials like super absorbent material is mixed with concrete, how it will affect its compressive strength. Whether the strength increases or decreases and whether this can be used for the real-life construction materials. The optimum addition of materials can also be identified with the help of plotting graph for various additions in variation. There are different ways to add super absorbent polymer in concrete. In this project we have used two types of mixing. First of all we mixed super absorbent polymer in water and after sudden interval of time we added in concrete. Secondly we added super absorbent polymer directly in concrete while mixing. And as our main objective is to improve the early age strength in concrete while using super absorbent polymer. So to overcome this problem we have used PC based accelerators (admixtures), we have selected M30 grade of concrete for the testing for which we have referred IS 456 and IS 10260.

INDEX TERMS Absorbent polymer, compressive strength, PC based accelerators (admixtures)

Introduction

There are some positive and negative effects of using super absorbent polymer in concrete. The two stages are fresh and harden state of concrete. Addition of sap in fresh concrete shows various positive effects. But the quantity of super absorbent polymer to be added is an important task or optimum % of super absorbent polymer in concrete the scientific name of super absorbent polymer is Sodium Polyacrylate. The main advantage of super absorbent polymer is to provide water in the concrete from inside for curing purposes. The super absorbent polymer introduces voids in concrete matrix and these voids reduce the strength of concrete. But due to presence of voids the concrete become more workable and improving the concrete stability. The main focus of this study is find the early compressive strength in concrete by adding suitable accelerators. To determine the early compressive strength several cubes were casted in different proportion of Super absorbent polymer and PC based accelerators. The super absorbent polymer should not be added more than 0.6-0.7% by weight of cement. Because it can alter the water cement ratio in the concrete and by early studies it is found that adding super absorbent polymer in concrete results in decrease in early strength of age in concrete. In our case we used super plasticizers and fly ash of C type. There are two advantages of using these admixtures by fly ash it reduces the cement content which makes the project economical and by using plasticizers it reduces water demand and research have shown super plasticizers somehow also contribute in strength point of view. And these admixtures were extensively used in RMC batching plant and this chemical admixtures also give some retarding time for concrete so that concrete do not settle immediately. As now days the advancements in construction industry involves the various technique such as “mivan form work” so it require early age strength in concrete so that to make project faster and economical so to cope-up with industrial needs we added PC based accelerators to enhance the strength of concrete. The accelerators are to be added in various proportions such as 0.7 %, 0.9%, 1.1%, by the weight of cement It is true that by adding super absorbent polymer strength loses initially because of slow hydration process. To ignite this hydration process we add accelerators. But for long term strength such as 28 days or 52 days as evidence have shown that there is a increase of strength in concrete used with super absorbent polymer without any admixtures. Curing is the most important part in concrete because without proper curing the concrete structure can results in cracking and lower targeted mean strength. And this initiative also help in water scarcity across the globe because as the environment is changing and daily rise in population is causing the decline in natural resources and portable water is one of the natural resources. As in INDIA there is there are many parts in country which are struggling for
3. MATERIALS

1. Super Absorbent Polymer As a name suggest it belong from a family of polymer and grinded in fine grains this method prevents self – desiccation. And it is made up of Sodium Polyacrylate. It absorbs the water in its surrounding in a certain rate. And they can absorb water up to 300-350 times of their own weight. They are added in a proportion of 0-0.6% by weight of cement. 2. Accelerators This kind of admixtures are basically used when we want early strength and there are two types of accelerators, PC based, and Naphtha based the chloride content is nil because it will provide deterioration in structure. And they increase the rate of hydration of hydraulic cement. 3. Coarse Aggregate We are used single size coarse aggregate of size 20 and 12.5mm. The size of the aggregate also has an important role in pervious concrete. Increasing the percent amount of larger aggregates will increase the void ratio in pervious concrete, but will decrease the compressive strength. 4. Fine aggregate As the natural river sand are exhausting during the construction industry there is abundant amount of portable water such as in Bangalore there is halt in hardened state. And super absorbent polymer releases water when drought occur within the structure depending on this mechanism this polymers had been used in concrete to obtain some benefits. It is used to for curing (internal curing agent), enhancing freezing and thawing resistance and reduce permeability; This corresponds to effect on the concrete Strength negatively or positively. It depends on the adopted method. They have used two different kind of curing method first method was they have immersed the cube in normal water and in open environmental conditions for 28 days. In second method they have used nylon bags for curing for 28 days of test.

K. Bala Subramanian et al., [2] The studies shows the concept of internal curing is to enhance the hydration process to maintain the temperature uniformity ,the research work was carried out to reduce water , which is prime material used for concrete in construction sector. In high strength concrete basically silica fumes types of admixture is used so cement is replaced by silica fumes by various proportions such as 5%, 10%, 15% and by studies and experiment it found that 10% of replacement gives more strength and durability. Kenneth Sequoia et al., [3] As the studies have shown in construction industry there is abundant amount of research is going on high strength of concrete and many more researchers are eager to work on the topic of internal curing of structure. In high strength concrete there is very high heat of hydration takes place. So the amount of water is needed for concrete microstructure. But most of the water is absorbed by concrete matrix. And this kind of process led to rise up shrinkage in concrete. But are different shrinkage reducing admixtures are used such as polyethylene glycol. And by usage of sap we can also work in cold climate where water is cooled immediately and hotter areas where evaporation took place significantly. Motahareh Rahimia et al., [4] From the studies it was found out that super absorbent polymer was first immersed in water before using in concrete and to analyze the behavior of it on self consolidating light weight concrete. And it was found out they have used super absorbent polymer of different grain size such as 1-4mm and 0.3 to 1mm and % of super absorbent polymer was kept constant on the order of 1.5% by weight of cement. From the test it was found out that the SAP improve passing ability and decreases the static stability of fresh SCLWC mixtures. And by usage of super absorbent polymer it reduces the early age strength of 3 and 7 days. And the objective was fulfilled because it is observed that there is to reduction in shrinkage in concrete by 50%. As compared to concrete without usage of Super absorbent polymer.

4. EXPERIMENTAL PROCEDURE

General Mix design is defined as the process of selection the suitable ingredients and determine their suitable. proportional to achieve the required strength and durability. 1. Cube mould Standard size cube mould are kept position on surface and then apply the oil inside of all side of cube. To prevent the sticking of concrete. 2. Mixing Prepared concrete mix well by hand or mechanical mixer with water cement ratio 0.4 to 0.45. 3. Placing Place the concrete in cube up to under beneath of cubes and spread it along sides with the help the travol. 4. Compaction Hand compaction is done for all cubes with the help the rod each layer should be well compacted. Each layer should be tamped 15 times with the help of rod. 5. Curing For curing of concrete block with super absorbent polymer it should not be placed in water. After demoulding the cubes must be kept in dry place. 6. Testing The testing of concrete plays an important role in controlling and confirming the quality of cement concrete cubes for it compressive strength.

5. TEST RESULTS

Table 1 Test on Cement

<table>
<thead>
<tr>
<th>Sr.no</th>
<th>Name of Test</th>
<th>IS code</th>
<th>Result</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fineness of cement</td>
<td>4031part 1991</td>
<td>331</td>
<td>M^2/kg min</td>
</tr>
<tr>
<td>2</td>
<td>Normal consistenc y</td>
<td>4031 part 1999</td>
<td>29.50</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Le–chatelier expansion</td>
<td>4031 part 1998</td>
<td>0.70</td>
<td>Mm</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Test Name</th>
<th>Result</th>
<th>Unit</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Specific Gravity</td>
<td>2.97</td>
<td>-</td>
<td>IS 2386 Part-3:1963</td>
</tr>
<tr>
<td>2</td>
<td>Water Absorption</td>
<td>1.11</td>
<td>%</td>
<td>IS 2386 Part-3:1963</td>
</tr>
<tr>
<td>3</td>
<td>Bulk density loose</td>
<td>1525</td>
<td>Kg/m³</td>
<td>IS 2386 Part-3:1963</td>
</tr>
<tr>
<td>4</td>
<td>Bulk density compacted</td>
<td>1654</td>
<td>Kg/m³</td>
<td>IS 2386 Part-3:1963</td>
</tr>
<tr>
<td>5</td>
<td>Flakiness Index (FI)</td>
<td>%</td>
<td>IS 2386 Part-1:1963</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Elongation Index (EI)</td>
<td>%</td>
<td>IS 2386 Part-1:1963</td>
<td></td>
</tr>
</tbody>
</table>

Table III Test on 12.5 mm aggregates

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Test Name</th>
<th>Result</th>
<th>Unit</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Specific Gravity</td>
<td>2.73</td>
<td>-</td>
<td>IS 2386 Part-3:1963</td>
</tr>
<tr>
<td>2</td>
<td>Water Absorption</td>
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<td>%</td>
<td>IS 2386 Part-3:1963</td>
</tr>
<tr>
<td>3</td>
<td>Bulk density loose</td>
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<td>Kg/m³</td>
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<td>4</td>
<td>Bulk density compacted</td>
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<td>5</td>
<td>Flakiness Index (FI)</td>
<td>9.28</td>
<td>%</td>
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<td>6</td>
<td>Elongation Index (EI)</td>
<td>8.02</td>
<td>%</td>
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</table>

Table IV Test on fine aggregates

<table>
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<tr>
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<th>Test Name</th>
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<th>Unit</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
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<td>1</td>
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<td>-</td>
<td>IS 2386 Part-3:1963</td>
</tr>
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<td>2</td>
<td>Water Absorption</td>
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<td>%</td>
<td>IS 2386 Part-3:1963</td>
</tr>
<tr>
<td>3</td>
<td>Bulk density loose</td>
<td>2010</td>
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</tr>
<tr>
<td>4</td>
<td>Bulk density compacted</td>
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<td>Kg/m³</td>
<td>IS 2386 Part-3:1963</td>
</tr>
</tbody>
</table>

Table V Test on concrete with SAP + admixture

<table>
<thead>
<tr>
<th>Description</th>
<th>Optimum</th>
<th>Days</th>
<th>Compressive strength of cube</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerators</td>
<td></td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>Pc based</td>
<td>0.70%</td>
<td>14.5</td>
<td>20</td>
</tr>
<tr>
<td>Sap</td>
<td>0.50%</td>
<td>17</td>
<td>24</td>
</tr>
<tr>
<td>3 Days</td>
<td></td>
<td>14.5</td>
<td>20</td>
</tr>
<tr>
<td>7 Days</td>
<td>0.70%</td>
<td>14.5</td>
<td>20</td>
</tr>
<tr>
<td>14 Days</td>
<td>0.70%</td>
<td>14.5</td>
<td>20</td>
</tr>
</tbody>
</table>

Table VI Test on concrete without SAP +accelerators

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Age</th>
<th>Weight</th>
<th>Density</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Days</td>
<td>kg</td>
<td>Kg/m³</td>
<td>MPA</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>8764</td>
<td>2596</td>
<td>13.6</td>
</tr>
</tbody>
</table>
6. CONCLUSION

Without accelerators and external curing When we introduced PC based accelerators with super absorbent polymer in concrete the highest strength was achieved as 26.45 MPA for 14 days of strength with internal curing. This is very near to characteristic strength of m30 grade of concrete without super absorbent polymer and external curing. So we also came to very important point the optimum % of accelerators to be used with super absorbent polymer is 0.7% by weight of cement and 0.5 % of SAP in crystalline form is found to be the optimum dosage. Early strength is achieved as high as possible 13.40 MPA which is nearly 45% of targeted mean strength. But there is no significant change in 3days and 7 days strength. It is nearly equivalent to m30 grade of concrete with external curing. So at last we can say by using this technique we can reduce the consumption of portable water for curing of concrete.

7. REFERENCES


Causes of Failure of Retaining Wall and It’s Prevention

Ms. Mohini B.Yewalekar¹, Ms. Meghna B.Yewalekar², Mr. Vishal S. Jain³, Mr. Aniket V. Samleti⁴, Prof. K.H. Ghorpade⁵

INTRODUCTION

The retaining walls are structures that are designed and constructed to withstand lateral earth pressure of soil or hold back soil materials. A retaining wall is permanent, relatively rigid structure made up of masonry or concrete that supports a mass of soil. It substitutes the steep face of the wall for the gentle natural slope of the earth to provide useable space in highway and road cut, in and around building and also in structures below ground level. The lateral earth pressure could be also due to earth filling, liquid pressure, sand & other granular materials behind Retaining Wall structure. Retaining walls are stabilizing structures that are used for holding back earth. There are many reasons for building these structures, some of which include preventing erosion, aesthetic purpose, and stabilizing sloped yards. Retaining Walls are frequently used to stabilize and modify slopes, level sites, and correct grade differences between properties. This is perhaps most common reason why hometown decides to construct retaining walls in their property. Retaining wall, if constructed properly can provide necessary earth support to make some parts of slope property level enough for recreational or practical use. Terraced retaining walls can also transform an otherwise ordinary garden into a layered paradise of plants and flowers.

Now-a-days retaining walls have been failing frequently; causing disasters to human life, properties and also economic losses. A damaged retaining wall can become a hazard to property and human safety. However many retaining walls are failing due to poor construction, poor drainage, poor quality of materials used during construction. This study includes overview of causes of failureof Retaining Wall. Study also includes the case of Failure of retaining wall in Pune Maharashtra in June 2019 due to heavy rain. The main reason of failure was due to water seeped into the backfill. In this study we have conducted field survey of walls that are failed and also the walls those are on verge of failure. Paper includes field investigation of failure cases, the test being carried out on the sites where failure has been occurred to know the failure parameters. The causes such as poor drainage, poor maintenance, and improper geological test lead to failure of wall. The brief study of wall failure in Pune Maharashtra has been done in this paper. This paper includes cause of failure of wall and what prevention can be provided. This paper also suggests a few possible solutions.

METHODOLOGY

First of all literature survey is being carried out to know the causes of failure of retaining wall. There are various construction, design, and detailing reasons that influence retaining wall safety and stability. The reasons for these types of failures are lack of proper reinforcement, improper drainage behind the wall (lack of weep holes or clogged holes), foundation footing problems, settlement or expansion of the soil, overloading of the wall. On the other hand, there are convenient measures or methods by which retaining wall problems can be decreased and prevent the retaining wall distress.

We studied type of retaining wall, modes of failure, visited failure sites of retaining wall, collected soil samples from site and conducted some test on soil to find soil parameter responsible for failure, and also we studied certain preventive measures to avoid failures occurring due to these reasons.
2.1 Modes of Retaining Wall Failure

1. **Sliding** – The backfill exerts a lateral pressure against the wall. This sliding force is resisted by the friction between the soil and the footing, and by the passive pressure at the front of the wall. When more sliding resistance is required, a shear key may be provided. The factor of safety against sliding equals the resisting force divided by the driving force, and the minimum value should be 1.50.

2. **Overturning** – The overturning moment from the applied forces must be resisted by an opposite moment produced by the vertical forces, including the wall self weight and the weight of the backfill over the heel. The factor of safety against overturning is defined as the resisting moment divided by the overturning moment, and the minimum value should be 1.50.

3. **Global Instability** – It assumes that a failure surface develops under the wall, causing a massive disturbance and movement of the soil along this surface. This check is a complex analysis that falls in the field of geotechnical engineering.

**G. SITE INVESTIGATION:**

**H. Site visits** are being carried out on different location of failure in Pune, Maharashtra. We have visited some failure sites and collected soil samples to conduct test so as to find possible reason of failure at particular site. This paper includes four different case studies at different locations in Pune as below.

**I. CASE STUDY I:**

A gravity retaining wall was constructed in the Shree swami Samarthkrupa Society. The length of the wall is about 250m. The height of the wall was 5 m above the foundation level. The wall was situated on a slightly sloping ground. The superstructure of the wall was resting on compacted gavel. The purpose of wall was to retain earth backfill on one side for 5m height. The wall also severs an purpose of compound wall as there is another apartment on other side of wall which is relatively at lower level than Swami samarthakrupa society. The soil sample was collected from the failure site so as to study the parameter responsible for failure.

**J. Shree swami Samarthkrupa Society, Katraj pune-411046**

**LABORATORY CLASSIFICATION OF CRITERIA FOR COARSE GRAINED SOIL (IS 1498)**

Determine percentage of gravel and sand from grain size curve depending upon percentage of fines (friction smaller than 75 Um Sieve Size) Coarse grained soil is as follow

1. Less than 5 %: GW, GP, SW, SP
2. More than 12 %: GM, GC, SM, SC
3. 5% to 12 %: border limne cases requiring use of dual symbol
<table>
<thead>
<tr>
<th>Group symbol</th>
<th>Laboratory classification of criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>GW</td>
<td>Cu greater than 4, Cc between 1 &amp; 3</td>
</tr>
<tr>
<td>GP</td>
<td>Not meeting requirement of GW</td>
</tr>
<tr>
<td>GM</td>
<td>IP less than 4</td>
</tr>
<tr>
<td>GC</td>
<td>IP greater than 7</td>
</tr>
<tr>
<td>SW</td>
<td>Cu greater than 6, Cc between 1 &amp; 3</td>
</tr>
<tr>
<td>SP</td>
<td>Not meeting requirement of SW</td>
</tr>
<tr>
<td>SM</td>
<td>IP less than 4</td>
</tr>
<tr>
<td>SC</td>
<td>IP greater than 7</td>
</tr>
</tbody>
</table>

### SIEVE ANALYSIS DATA SHEET

<table>
<thead>
<tr>
<th>R NO</th>
<th>IS SIEVE</th>
<th>PARTICAL SIZE D mm</th>
<th>Weight retained(gm)</th>
<th>% retained</th>
<th>Cumulative % retained</th>
<th>% Finer 100 – (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100 mm</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>63 mm</td>
<td>63</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>20 mm</td>
<td>20</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>10 mm</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>100</td>
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<tr>
<td>5</td>
<td>4.75 mm</td>
<td>4.75</td>
<td>1.4</td>
<td>1.4</td>
<td>1.4</td>
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</tr>
<tr>
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<td>2 mm</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>1.4</td>
<td>98.6</td>
</tr>
<tr>
<td>7</td>
<td>1.18 mm</td>
<td>1.18</td>
<td>128</td>
<td>12.8</td>
<td>14.2</td>
<td>85.8</td>
</tr>
<tr>
<td>8</td>
<td>600 um</td>
<td>0.5</td>
<td>136</td>
<td>13.6</td>
<td>27.8</td>
<td>72.2</td>
</tr>
<tr>
<td>9</td>
<td>425 um</td>
<td>0.425</td>
<td>208</td>
<td>20.8</td>
<td>48.6</td>
<td>51.4</td>
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<tr>
<td>10</td>
<td>300</td>
<td>0.300</td>
<td>222</td>
<td>22.2</td>
<td>70.8</td>
<td>29.2</td>
</tr>
<tr>
<td>11</td>
<td>150 UM</td>
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<td>216</td>
<td>21.6</td>
<td>92.4</td>
<td>7.6</td>
</tr>
<tr>
<td>12</td>
<td>75 UM</td>
<td>0.075</td>
<td>28</td>
<td>2.8</td>
<td>95.2</td>
<td>4.8</td>
</tr>
<tr>
<td>13</td>
<td>PAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Sieve analysis data sheet

**Graph 1: Particle size distribution curve**

**Calculation:**
- Uniformity coefficient, \( Cu = \frac{D_{60}}{D_{10}} \)
- Coefficient of Curvature, \( Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}} \)

\[
Cu = \frac{0.480}{0.170} = 2.82 \\
Cc = \frac{(0.310)^2}{0.480 \times 0.170} = 1.18
\]

**Result:**
Percent of fine is less than 5%

**3.3 Liquid limit**
Liquid limit is significant to know the stress history and general properties of the soil met
with construction. From the results of liquid limit the compression index may be estimated. **Objective:** From liquid limit test, the compression index may be estimated, which is used in settlement analysis. If the natural moisture content of soil is higher than liquid limit, the soil can be considered as soft and if the moisture content is lesser than liquid limit, the soil is brittle and stiffer. The value of liquid limit is used in classification of the soil and it gives an idea about plasticity of the soil.

### 3.3.1 Observation & Calculation

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>Determination No</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Container No</td>
<td>I</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>2</td>
<td>No. Of blows</td>
<td>17</td>
<td>23</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>Wt. Of container (W)</td>
<td>20.18</td>
<td>22.18</td>
<td>24.19</td>
</tr>
<tr>
<td>4</td>
<td>Wt. of Container = wet soil, gm (W1)</td>
<td>38.24</td>
<td>36.10</td>
<td>40.4</td>
</tr>
<tr>
<td>5</td>
<td>Wt. of container + wt of dry soil, gm (W2)</td>
<td>33.52</td>
<td>32.46</td>
<td>36.43</td>
</tr>
<tr>
<td>6</td>
<td>Wt. of water (W1 – W2)</td>
<td>4.72</td>
<td>3.64</td>
<td>3.71</td>
</tr>
<tr>
<td>7</td>
<td>Wt. of oven dry soil, gm (W2-W)</td>
<td>13.34</td>
<td>11.09</td>
<td>12.15</td>
</tr>
<tr>
<td>8</td>
<td>Water content (%)</td>
<td>35.3</td>
<td>32.82</td>
<td>30.52</td>
</tr>
</tbody>
</table>

**Table 3: Observation and calculation of Liquid limit**

**Geotechnical characteristic of backfill**

<table>
<thead>
<tr>
<th>% passing sieve no300</th>
<th>29.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classification of soil</td>
<td>poorly graded soil</td>
</tr>
<tr>
<td>Liquid limit</td>
<td>31.92%</td>
</tr>
<tr>
<td>Plastic limit</td>
<td>30.62%</td>
</tr>
<tr>
<td>Plasticity index</td>
<td>10.76%</td>
</tr>
<tr>
<td>Classification of soil (Is1498)</td>
<td>CL type that is clay with low compressibility</td>
</tr>
</tbody>
</table>

**Table 4: Physical characteristic of backfill**

As per field study and soil investigation the cause of failure and preventive measure that can be provided is mentioned in below table

**Poor drainage :** Since retaining walls are generally designed assuming a well drained granular backfill, if surface drainage is allowed to penetrate and accumulate in the backfill, the pressure against the wall can be doubled. Ponding of water behind the wall not only indicates poor grading, but clayey soil impounding the correct surface drainage problems: Economically replace the backfill or get to the base-of-wall drainage system, but you can re-grade at the surface so water does not collect behind the wall. Perhaps a small concrete culvert. Often just shutting off an over active irrigation system will solve the problem. Additional weep holes can also be cored through the downward seepage of water.

**Foundation problem**

When a geotechnical investigation is provided, there will be guidelines for design (allowable soil bearing, friction factors, seismic if applicable) and any caveats based upon site conditions, such as liquefaction potential. Following these, the designer should be aware of any adverse conditions, such as fill material, compressible soil, water table, or other factors that could cause excessive settlement? Or sliding. Recommendations should assure a trouble-free foundation. However, often such an investigation is not provided, calling for special care by the designer. Without such a geotechnical report the soil bearing is limited by code.

**Geotechnical investigation**

 Proper compaction of the soil underneath the wall is crucial to prevent this problem. Compacting removes space between soil particles and creates a denser surface to serve as the foundation of the wall. If the soil underneath the retaining wall is too weak, adding gravel or aggregate, and then compacting it, can also help add stability.

<table>
<thead>
<tr>
<th><strong>Table 5: Cause of failure and preventive measure</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Case study II:</strong></td>
</tr>
<tr>
<td><strong>Gabion Retaining Wall at It Park Magarpatta Pune, Maharashtra, India Magarpatta, Pune.</strong></td>
</tr>
<tr>
<td>It is a self-contained residential cum industrial / corporate settlement spanning over 700 Acres of land. Its award winning design and eco friendly construction made it the first such settlement in India to receive the. For this purpose a fill of around 6-7 m was provided, the slope of which had to be protected. Also a canal passes by the edge of the fill, so there will be chances of developing hydrostatic forces. The soil present at the site is Black cotton. Considering the engineering properties of soil, foundation replacement was also advised.</td>
</tr>
<tr>
<td><strong>4.1 Experimental work:</strong></td>
</tr>
<tr>
<td>Since Black Cotton soil is highly sensitive to seasonal moisture content variations and can lead to distress of the structure, foundation replacement was done with stone dumping. To provide protection to the slope of the fill</td>
</tr>
</tbody>
</table>
and the canal, Gabion wall was constructed. The MACCAFERRI Gabion is a rectangular cage made of hexagonal woven steel wire mesh. They are uniformly partitioned, of variable sizes, interconnected with adjacent cages and filled with stone at the site of use, to form flexible, permeable, monolithic structures such as retaining walls for road and railway projects. As rigid structures are costlier and exert pressure at the base, the flexible gabion walls are happen to be quite suitable for specified condition as these are flexible, cost effective, compatible and environment friendly as it allows vegetation. Separate drainage arrangements is not required for Gabion walls as they are permeable.

The extensive land, stream bank or surfaces and local scour is the removal of single particle from the base of river, collapse of the wall.

<table>
<thead>
<tr>
<th>Bulging</th>
<th>Preventive Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>More Voids leads to rearrangement of stones causing bulging</td>
<td></td>
</tr>
<tr>
<td>Improper or Loose Packing also If smaller size stones are used it may split out from mesh opening and may bulge more than stones with all size.</td>
<td>Fill your gabion basket by hand Place the flat surfaces of the rock against the wall of the basket Use high quality, high gauge steel (at least 4mm gauge)</td>
</tr>
</tbody>
</table>

Table 6: Cause of failure and preventive measure

- **Case study III:**

  The wall was cantilevered retaining wall which is constructed for about 10-15 years. The height of wall is 6 m above the foundation level. The wall is having a crack from top to bottom. The purpose of having crack on wall and slightly deflected due to not providing weep holes properly / improper drainage, and improper design of wall.

  Cantilevered retaining walls are made from an internal stem of steel-reinforced, cast-in-place concrete or mortared masonry (often in the shape of an inverted T). These walls cantilever loads (like a beam) to a large, structural footing, converting horizontal pressures from behind the wall to vertical pressures on the ground below. Sometimes cantilevered walls are buttressed on the front, or include a counter fort on the back, to improve their strength resisting high loads. Buttresses are short wing walls at right angles to the main trend of the wall. These walls require rigid concrete footings below seasonal frost depth. This type of wall uses much less material than a traditional gravity wall.

---

**Fig. 5 Site visit to Gabion retaining wall**

4.2 Causes of wall failure & its prevention:

<table>
<thead>
<tr>
<th>Cause of failure</th>
<th>Preventive Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erosion of soil foundation</td>
<td>Protection to foundation If the wall is located in rainfall and mountainous area or near flowing stream, without foundation protecting blanket, soil under foundation get wash out leads to the</td>
</tr>
</tbody>
</table>

---

**Table 6: Cause of failure and preventive measure**

- **Case study III:**

  The wall was cantilevered retaining wall which is constructed for about 10-15 years. The height of wall is 6 m above the foundation level. The wall is having a crack from top to bottom. The purpose of having crack on wall and slightly deflected due to not providing weep holes properly / improper drainage, and improper design of wall.

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5.1 Experimental work
The backfill soil of the Retaining wall in Katraj area was collected. The wall is about to fail, which is used to perform the experiments for determining the shear strength parameters. The average density of particles ($\rho_s$) value of cohesionless soil is 2.71 Mg/m³ and ranges from 2.65 to 2.67 Mg/m³. The vertical stress magnitudes of 100, 200, 300 KPa have been applied. The soil is sheared under the constant horizontal displacement $v$ velocity of 0.5 mm/min until the horizontal deformation reaches the limit of 9 mm. The shear test is performed under different cases (methods), namely: when constant vertical stress ($q = \text{const.}$) is applied; when constant sample volume ($h = \text{const.}$) is applied. The shear tests have been performed for loose soil (density $\rho = 1.491$ g/cm³). The peak soil shearing strength has been determined according to the maximum ratio of tangential and normal stresses, i.e., $\tau/\sigma = \text{max}$.

5.2 Direct Shear Test:
In many engineering problems such as design of foundation, retaining walls, slab bridges, pipes, sheet piling, the value of the angle of internal friction and cohesion of the soil involved are required for the design. Direct shear test is used to predict these parameters quickly. The laboratory report, cover the laboratory procedures for determining these values for cohesionless soils.

### Table 7: Observation & calculation of Direct shear test

<table>
<thead>
<tr>
<th>Sr No.</th>
<th>Horizontal displacement</th>
<th>Corrected Area</th>
<th>Normal Stress = 0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5</td>
<td>35.70</td>
<td>5  1.37  0.04</td>
</tr>
<tr>
<td>2</td>
<td>1.0</td>
<td>35.40</td>
<td>13 3.56  0.110</td>
</tr>
<tr>
<td>3</td>
<td>1.5</td>
<td>35.10</td>
<td>17 4.66  0.13</td>
</tr>
</tbody>
</table>

### Table 8: Max. Normal and shear stress

<table>
<thead>
<tr>
<th>Sr No.</th>
<th>Max Normal Stress</th>
<th>Max Shear Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.50</td>
<td>0.59</td>
</tr>
<tr>
<td>2</td>
<td>1.00</td>
<td>1.12</td>
</tr>
<tr>
<td>3</td>
<td>1.50</td>
<td>1.57</td>
</tr>
</tbody>
</table>

5.3 Observation and calculation

#### Sr. No. | Horizontal displacement | Corrected Area | Normal Stress = 0.5
---|-------------------------|----------------|---------------------
1 | 0.5 | 35.70 | 5  1.37  0.04 |
2 | 1.0 | 35.40 | 13 3.56  0.110 |
3 | 1.5 | 35.10 | 17 4.66  0.13 |

#### Table 8: Max. Normal and shear stress

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<thead>
<tr>
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<tbody>
<tr>
<td>1</td>
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<td>1.12</td>
</tr>
<tr>
<td>3</td>
<td>1.50</td>
<td>1.57</td>
</tr>
</tbody>
</table>

5.4 Cause of wall failure & its prevention:

<table>
<thead>
<tr>
<th>Cause of failure</th>
<th>Preventive measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor Drainage: The main cause of retaining wall failure is poor drainage. Without proper drainage, hydrostatic pressure builds up behind the retaining wall. Saturated soil is substantially heavier than dry soil, and the retaining wall may not be designed to handle such a load. And it may tend to failure of wall.</td>
<td>Replacing backfill materials or reaching to the drainage system at retaining wall base is uneconomical. Therefore, it is recommended to prevent accumulating water at the back face of the wall by re-grading backfill material surface or constructing small concrete culvert to divert water and direct it away from the backfill. Moreover, increasing number of weep holes might be another mitigation strategy, even though it can be objectionable aesthetically. Furthermore, in most cases, it is feasible to solve drainage issues by just closing active drainage systems.</td>
</tr>
<tr>
<td>Sub-Standard Materials or Lack of Reinforcement. The use of a poor concrete mix, the lack of supports or the lack of reinforcing bars are also causes of retaining wall failure. Remember that even a 4-feet-high, 15-feet-long retaining wall could be holding back as much as 20 tons of soil.</td>
<td>The base thickness is increased to reinforce the front of the wall through placing concrete and tapering to an extent that thickening is no longer required. This method improves compression strength only therefore shear transferring at the interface should be tackled as well. Interface shear can be transferred by fixing dowel pins.</td>
</tr>
</tbody>
</table>
Proper planning and designing should be done.

Table 9: Cause of failure and preventive measure

- **Case study IV:**

It is a cantilever retaining wall but strengthened with counter-forts monolithic with the back of the wall slab and base slab. Counter-fort spacing is equal or slightly larger than half of the counter-fort height. Counter-fort wall height ranges from 8-12m.

![Fig 8: Counter-fort/Buttress Retaining Wall](image)

Ambil Odha, PMC to construct retaining wall, Sahakar nagar pune-411009.

The backdrop of 25th Sep 2019 flash floods in the city, the Pune municipal Corporation (PMC) had proposed to construct retaining wall along the canals to prevent floods before the 2020 monsoon. About the retaining wall, the civic body has proposed to build a 3km wall along 45 most affected locations in Ambil Odha to prevent flood waters from entering the residential area.

6.1 Experimental work

The result obtain from compaction test, Optimum moisture content and Dry Density of soil from plot graph and the C5 test to know the Property of Particle size analysis, pH, Equivalent CaCO3, Organic Matter, Total Nitrogen, Exchangeable Cations, Available Phosphorus, Total concentration of metals (Zn, Cu, Mn and Fe), Available concentration of metals (Zn, Cu, Mn and Fe)

![Fig 9: Failure of Wall at Ambil Odha](image)

### 6.1.1 Modified proctor Test & Density Determination Observation & Calculation

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>Determination no.</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mass of empty mould with base plate</td>
<td>2866.0</td>
<td>2866.0</td>
<td>2866.0</td>
</tr>
<tr>
<td>2</td>
<td>Volume of mould (b)</td>
<td>2106.0</td>
<td>2106.0</td>
<td>2106.0</td>
</tr>
<tr>
<td>3</td>
<td>Mass of mould + Wet of soil (c)</td>
<td>7352.0</td>
<td>7658.0</td>
<td>7880.0</td>
</tr>
<tr>
<td>4</td>
<td>Mass of wet soil (d = c-a)</td>
<td>4486.0</td>
<td>4792.0</td>
<td>5014.0</td>
</tr>
<tr>
<td>5</td>
<td>Wet Density of soil (e = d/b)</td>
<td>2.130</td>
<td>2.275</td>
<td>2.381</td>
</tr>
</tbody>
</table>

Table 10: Modified proctor test – observation and calculation

![Fig 9: Proctor test apparatus](image)

**Moisture content Determination**

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>Observation</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mass of container (f)</td>
<td>35.9</td>
<td>31.7</td>
<td>37.3</td>
</tr>
</tbody>
</table>
Table 11: Moisture content determination observation and calculation

<table>
<thead>
<tr>
<th></th>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Mass of container + Wet of soil (g)</td>
<td>352.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>340.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>363.2</td>
</tr>
<tr>
<td>3</td>
<td>Mass of container + Dry soil (i=g-h)</td>
<td>346.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>330.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>348.9</td>
</tr>
<tr>
<td>4</td>
<td>Mass of Water (i=g-h)</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14.3</td>
</tr>
<tr>
<td>5</td>
<td>Mass of Dry soil (j=h-f)</td>
<td>310.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>298.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>311.6</td>
</tr>
<tr>
<td></td>
<td>Moisture content (k=i/j*100)</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>Dry Density of soil (l=e/(100+k)*100)</td>
<td>2.086</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.204</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.276</td>
</tr>
</tbody>
</table>

Table 12: Results of C5 Test

<table>
<thead>
<tr>
<th></th>
<th>K (ppm)</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total N (%)</td>
<td>0.147</td>
</tr>
<tr>
<td></td>
<td>Total concentration of metals (Zn, Fe, Mn, Cu)</td>
<td>To be evaluated</td>
</tr>
<tr>
<td></td>
<td>Available concentration of metals (Zn, Fe, Mn, Cu)</td>
<td>To be evaluated</td>
</tr>
</tbody>
</table>

6.4 Cause of wall failure & its prevention:

<table>
<thead>
<tr>
<th>Cause of Failure</th>
<th>Preventive Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retaining Wall Failure due to Age</td>
<td>Proper maintenance of retaining wall can be done. Which can be resisting the failure of retaining wall and to minimize the accidental cases? After the age can be completed of structure it can be demolished and again it can be constructing.</td>
</tr>
<tr>
<td>Design Error</td>
<td>Concrete retaining walls need to be properly reinforced to provide adequate strength. Reinforcement often comes in the form of rebar in the wall. Using the rebar properly can be a challenge, and the corners are especially challenging. If the rebar is not properly used, the wall will separate at the corners and fail early</td>
</tr>
</tbody>
</table>

6.3 Test 2:-C5 Test:
The soil analysis of the implementation area comes as a part of Action C5 of the project. Samples from each experimental segment were collected during the field visit of offering a recent baseline of data for the comparative assessment of soil quality, before and after the application of sewage sludge.

6.2 Observation & Calculation

Result:
Maximum Dry Density (from plot) = 2.284gm/cc
Optimum moisture content (from plot) = 5.2

Table 13: Cause of failure and preventive measure

- CONCLUSION:
Failure observed in site investigation are cracks, bulging, sliding, tilting, bending, or some other mechanism, occurs when these permanent deformations become excessive. Most of these failure occurred due to poor drainage, design error, foundation erosion, and faulty
reinforcement and maintenance. Solution of such problem can be done by correct surface drainage problem, protection of foundation and by proper geotechnical investigation. Back fill should be properly compacted and selection of backfill material should be made proper so that for flood water behind the wall would pass on the other side and the less pore water pressure will be develop good backfill material should be used with good drainage characteristics to prevent hydrostatic pressure build – up. A situation where it is not available, water should be prevented from getting into the backfill material to prevent a build – up hydrostatic pressure Alternative should be cost effective and eco-friendly solution

ACKNOWLEDGMENT
It’s a genuine pleasure to express my thanks to my , Prof. Kiran H. Ghorpade, Trinity Academy of Engineering, Pune. Their timely, scholarly advice, meticulous scrutiny and scientific approach helped me to a very great extent to accomplish this task.
I would also thank my HOD Dr. S. S. Deshmukh and Principal Dr. N. J. Uke and Institution for unconditional support.

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A SOLUTION TO SOLVE DRAUGHT OF MARATHWADA THROUGH GODAWARI MANJARA INTERLINK

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ABSTRACT
India is one of the few countries in the world endowed with the reasonable land and water resources. Being a monsoon country the rainfall is erratic, unevenly distributed and hence water scarcity in some parts and floods in other parts frequently occur. Marathwada which is a region of Maharashtra state is as dry as hell in dry seasons. The people of Marathwada are facing the critical problems related with storage and distribution of water due to erratic rainfall and uneven distribution of water. The water scarcity in Marathwada region results in suicide of many farmers and this number is going on increasing every year. Water scarcity is also responsible for lack of drinking water during summer season and Maharashtra government transfer water from Miraj to Latur district by Water train known as Jaldoot. Green revolution is not possible without blue revolution in Marathwada, so to tackle with all water scarcity related problems, We have proposed Godavari-Manjara interlink project in which the surplus water of Godavari river in rainy season is diverted towards the reservoir constructed in Latur and Beed district.

This paper identifies the reservoirs Manjara Dam and Babhalgaon dam as part of proposed Godavari-Manjara link and examines inundated regions of Beed, Osmanabad and Latur district after completion of the project.

KEY WORDS  Godavari, Manjara, Interlink, irrigation, discharge, submerged area, canal.

INTRODUCTION
Water is undoubtedly the most important natural resource on the planet, as it sustains all aspects of life in a way that no other resource can. Water plays a significant role in the field of agriculture also. Water resources are however limited due to developmental activities, industrialization, pollution, population, dropped rainfall levels, droughts, floods and other factors. The only time when people realize the scarcity of water is when there is drought or water supply of water is not been regulated. Increased pollution, population, industrialization, deforestation, urbanization and depleting natural resources. Drought and Flood are natural disasters caused by climate change which are the major water concerns in the country happens due to heavy and low rainfall. India is one of the few countries in the world endowed with the reasonable land and water resources. Being a monsoon country the rainfall is erratic, unevenly distributed and hence water scarcity in some parts and floods in other parts frequently occur. Keeping in mind the increasing demand for water, the government of India has developed a new National Water Policy which claims that water is a prime natural resource, a basic need and a precious national asset. India’s National Water Development Agency (NDWA) has suggested the Interlinking of River project which is best known as (ILR) project.

FIG. 1 INTERLINKING PROJECTS IN INDIA

OBJECTIVE
The objectives of Godavari-Manjara Interlink Project are as follows :
• To use the available water of Godavari river effectively by transferring the surplus water towards water scarce areas. • Godavari-Manjara Interlink Project meets the
water requirement of Districts like Beed, Latur and Osmanabad of Marathwada region.
• To increase the irrigation potential of the drought prone area.
• To help to reduce the stress on ground water and to effectively increase the ground water level.
• The water scarcity in Marathwada region results in suicide of farmers due to crop failure and economic losses. We have proposed this project to meet the water requirement for irrigation purposes and to stop the suicide of farmers.
• To make ample water available which will increase the irrigation potential of the drought prone area and will ultimately increase the productivity of land.
• The crops in the Marathwada region are mainly rain fed crops. The farmers depend upon rain water for the crop production. This project will inspire farmers to take cash crops and their annual income will increase considerably.

Thus, the objective of this project is to transform the Dry Hell of Marathwada region into Nandanvan.

WATER CRISIS IN MARATHWADA
While most parts of Maharashtra receives average monsoon rainfall this season so far, water stock in the drought-prone Marathwada region in central Maharashtra stands at just 20 percent of its total capacity. Currently villages across Marathwada are still relying on 339 tankers of a total of 500 deployed in the state for drinking purposes. In July, Marathwada received only 54% of the normal rainfall. Marathwada has been reporting frequent droughts over the past few years, which has made a region a centre for farmer suicides and agrarian crisis due to falling prices of produce. In the year 2018, around 689 farmers have ended their life because of crop failure and worst economical conditions.

The following tabular data shows the information about Beed and Latur districts.

1) BEED DISTRICT

<table>
<thead>
<tr>
<th>Population</th>
<th>29,79,634</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Rainfall</td>
<td>692.8 mm</td>
</tr>
<tr>
<td>Source available</td>
<td>Manjara Dam (8 TMC)</td>
</tr>
<tr>
<td></td>
<td>Majalgaon Dam (11 TMC)</td>
</tr>
<tr>
<td></td>
<td>Ground Water (42.78 TMC)</td>
</tr>
<tr>
<td></td>
<td>Other Reservoirs (4 TMC)</td>
</tr>
<tr>
<td>Total Cultivable Land</td>
<td>9,52,000 ha</td>
</tr>
<tr>
<td>Total Irrigated Land</td>
<td>1,69,000 ha</td>
</tr>
<tr>
<td>Percentage of Irrigation</td>
<td>17.7%</td>
</tr>
<tr>
<td>Water required</td>
<td>For Drinking – 7.58 TMC</td>
</tr>
</tbody>
</table>

For Agriculture- 170 TMC (by considering 100% irrigation)

2) LATUR DISTRICT

<table>
<thead>
<tr>
<th>Population</th>
<th>28,54,196</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Rainfall</td>
<td>700 mm</td>
</tr>
<tr>
<td>Source available</td>
<td>Manjara Dam (8TMC)</td>
</tr>
<tr>
<td></td>
<td>Ground Water (33.72TMC)</td>
</tr>
<tr>
<td></td>
<td>Other Reservoirs (7 TMC)</td>
</tr>
<tr>
<td>Total Cultivable Land</td>
<td>7,08,669 ha</td>
</tr>
<tr>
<td>Total Irrigated Land</td>
<td>1,13,008 ha</td>
</tr>
<tr>
<td>Percentage of Irrigation</td>
<td>15.9%</td>
</tr>
<tr>
<td>Water required</td>
<td>For Drinking – 7.26 TMC</td>
</tr>
<tr>
<td></td>
<td>For Agriculture- 140 TMC (by considering 100% irrigation)</td>
</tr>
</tbody>
</table>

HYDROLOGY OF GODAVARI BASIN
The river Godavari rises at an elevation of 1,067 m in the Western Ghats near Trambakeshwar Hills in the Nasik district of Maharashtra. After flowing for about 1,465 km, in a generally south-east direction, it falls into the Bay of Bengal. Godavari is an important river in India and it flows from western to southern India. The drainage basin of the river is present in Maharashtra, Karnataka, Telangana, Andhra Pradesh and Puducherry. Godavari river flows through Aurangabad, Beed, Jalna, Parbhani and Nanded districts in Marathwada region. It extends a total geographically calculated area of 302065.10 Sq. km with a maximum length and width of about 995 km and 583 km, respectively.

The hydrology of Godavari basin and its tributaries are shown in the following figure:
The below Hystograph shows the monthly discharge values at Yelli station. From this Histogram it is computed that the annual discharge of Godavari river at Yelli is about 148 TMC which flows in Telangana State. The total amount of water flowing towards Telangana state is about 176.45 TMC which includes the discharge of Manar (4.45 TMC) and Lendi (24TMC) rivers. But the total water requirement of Telangana state is about 120 TMC including the total capacity of Sriramsagar Dam (90 TMC) and Nizamsagar Dam (30 TMC). So, the total surplus water available is about 56.45 TMC. By considering need of Telangana state and other parameter we can divert 23 TMC of water from Yelli station towards draught prone area of Marathwada.

<table>
<thead>
<tr>
<th>Month</th>
<th>Average discharge cumec</th>
</tr>
</thead>
<tbody>
<tr>
<td>June</td>
<td>9</td>
</tr>
<tr>
<td>July</td>
<td>215</td>
</tr>
<tr>
<td>August</td>
<td>29</td>
</tr>
<tr>
<td>September</td>
<td>906</td>
</tr>
<tr>
<td>October</td>
<td>601</td>
</tr>
</tbody>
</table>

The Link route of Godavari-Manjara Interlink is shown in the figure 5 which passes through three districts of Marathwada region which are Nanded, Latur and Beed.
PHASE I (YELLI TO KALKA)

Canal link from Yelli to Kalka in Nanded district. This phase will include the construction of water divergent structure on Godavari river at yelli which will store and divert water towards Manjara dam through canal. The total capacity of this reservoir at yelli will be 15 TMC. The total length of the canal in phase I will be 59 kilometers. The flow of water through canal will be gravity flow.

Phase I Specifications

<table>
<thead>
<tr>
<th>Source</th>
<th>Yeli (383m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Destination</td>
<td>Kalka (371m)</td>
</tr>
<tr>
<td>Length of canal</td>
<td>59 km</td>
</tr>
<tr>
<td>Number of Reservoir</td>
<td>1 (Yeli dam)</td>
</tr>
<tr>
<td>Cross Section of Canal</td>
<td>Trapezoidal</td>
</tr>
</tbody>
</table>

Table no. 3
Reservoir Specifications

<table>
<thead>
<tr>
<th>Name</th>
<th>Yeli dam</th>
</tr>
</thead>
<tbody>
<tr>
<td>River</td>
<td>Godavari</td>
</tr>
<tr>
<td>Location</td>
<td>Yeli Village</td>
</tr>
<tr>
<td>Height</td>
<td>45m</td>
</tr>
<tr>
<td>Total capacity</td>
<td>15 TMC</td>
</tr>
<tr>
<td>Submergence Land</td>
<td>1886 ha approx.</td>
</tr>
<tr>
<td>Land to be acquired</td>
<td>2452 ha approx.</td>
</tr>
<tr>
<td>Purpose</td>
<td>Irrigation, Drinking</td>
</tr>
<tr>
<td>Area Irrigated</td>
<td>30000 ha (Nanded)</td>
</tr>
<tr>
<td>Water Distribution</td>
<td>Nanded District - 50%, Latur, Beed Districts - 50%</td>
</tr>
</tbody>
</table>

PHASE II (KALKA TO TELGAON)

Phase II of the project includes canal link from Kalka to Telgaon. The Telgaon station is at higher elevation than kalka. There is difference of about 189 m in the elevation of telgaon and Kalka. Water in the canal is required to be lifted to overcome the route obstructions. There will be Pumping Station situated near Kalka which will pump the water from small reservoir constructed for pumping purpose. The water will be lifted upto suitable height and further it will pass through tunnel constructed in the hill and the water will be discharged in the canal on the other side.

Phase II Specifications

<table>
<thead>
<tr>
<th>Source</th>
<th>Telgaon (560m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Destination</td>
<td>Telgaon (560m)</td>
</tr>
<tr>
<td>Length of Canal</td>
<td>55 km</td>
</tr>
<tr>
<td>Reservoir</td>
<td>Near Telgaon (1TMC)</td>
</tr>
<tr>
<td>Lake</td>
<td>(0.2 TMC)</td>
</tr>
<tr>
<td>Pumping Power Station</td>
<td>Required</td>
</tr>
<tr>
<td>Cross Section of Canal</td>
<td>Trapezoidal</td>
</tr>
</tbody>
</table>

PHASE III (TELGAON TO KALLAM)

Phase III of the project consists of canal link from Telgaon (Latur District) to Kallam (Beed District) where Manjara dam is situated. The total length of this link will be 112 kilometers. Similar to phase II, pumping of water will be required due to obstruction of Balaghat mountain range which has an elevation of 600 meters above mean sea level. To overcome this obstruction, one pumping station will be provided near Saygaon.

The water from canal in phase III will be discharged in Manjara Dam in Beed district. The current capacity of Manjara Dam is 8 TMC. Manjara dam supplies water to Beed, Osmanabad and Latur districts.

Table no. 5 Phase III Specifications

<table>
<thead>
<tr>
<th>Source</th>
<th>Manjara dam</th>
</tr>
</thead>
<tbody>
<tr>
<td>River</td>
<td>Manjara</td>
</tr>
<tr>
<td>Location</td>
<td>Near Kallam City</td>
</tr>
<tr>
<td>Height</td>
<td>25m</td>
</tr>
<tr>
<td>Current capacity</td>
<td>8 TMC</td>
</tr>
<tr>
<td>Purpose</td>
<td>Irrigation, Drinking, Industry</td>
</tr>
<tr>
<td>Area Irrigated</td>
<td>32000 ha</td>
</tr>
</tbody>
</table>

Table no. 4 Phase II Specifications
PHASE IV (TELGAON TO BABHALGAON)

Phase IV includes transfer of water from Telgaon to Babhalgaon and construction of Babhalgaon dam which will be constructed on Manjarariver in Latur district. Water will be supplied to Babhalgaon dam and Manjara dam from the Yelli dam through canal as per requirement to tackle with water scarcity condition in summer season. The babhalgaon dam will fulfil the water requirement of Latur district. Further water in Babhalgaon dam will transfer to Reservoir in Nilanga through canal of length 37 kilometers to solve the problem of water scarcity in Nilanga region. Water will also transfer to Devarjan by pipelines to solve water scarcity problem in that area.

Table no. 7 Phase IV Specifications

<table>
<thead>
<tr>
<th>Source</th>
<th>Telgaon (560m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Destination</td>
<td>Babhalgaon (508m)</td>
</tr>
<tr>
<td>Length of Canal</td>
<td>55 km</td>
</tr>
<tr>
<td>Reservoir</td>
<td>Babhalgaon dam (12 TMC) Reservoir Near Nilanga (1.5TMC) 2 Lakes between Telgaon to Babhalgaon of capacity 0.25 TMC</td>
</tr>
<tr>
<td>Pumping Power Station</td>
<td>Required</td>
</tr>
<tr>
<td>Cross Section of Canal</td>
<td>Trapezoidal</td>
</tr>
</tbody>
</table>

Table no. 8 Construction of Babhalgaon Dam

<table>
<thead>
<tr>
<th>Name</th>
<th>Babhalgaon dam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Near Babhalgaon (Latur District)</td>
</tr>
<tr>
<td>River</td>
<td>Manjara</td>
</tr>
<tr>
<td>Height</td>
<td>41m</td>
</tr>
<tr>
<td>Total Capacity</td>
<td>12 TMC</td>
</tr>
<tr>
<td>Submergence land</td>
<td>1800 ha</td>
</tr>
<tr>
<td>Benefited Area</td>
<td>Latur District</td>
</tr>
<tr>
<td>Area Irrigated</td>
<td>25000 ha.</td>
</tr>
<tr>
<td>Water reserved</td>
<td>3.5 TMC (for March, April, May,June) Babhalgaon dam to NilangaReservoir (37 Km) Water transfer from dam to Devarjan Lake through pipeline (42 Km)</td>
</tr>
</tbody>
</table>

Maharashtra has maximum number of large dams in country but state has failed in providing water to its people. In Marathwada water table has gone down by 3 to 4 metre in the past 2 years. Only transfer of water not solve the problem of scarcity completely. Proper distribution of water, Proper cropping pattern which is suitable to geographical situation of particular region, proper allocation of water are plays important role to tackle with water scarcity problem. Many times water is utilize for water intensive crops like sugarcane and for industries like sugar factories and it will create problem of water scarcity in summer season hence in this project we reserved some water in both the dams (Babhalgaon&yeli dam) for four months of summer season to tackle with water scarcity problem in summer season in Marathwada.

ADVANTAGES

Godavari-Manjara link route aims to transfer surplus water of Godavari river towards the drought prone areas of Marathwada region to tackle with the water scarcity conditions. If this project is executed by the Central Government, then it will have following advantages:

- The Godavari-Manjara Link route will bring Water Revolution in drought prone Marathwada.
- Marathwada region faces drought condition almost every year due to erratic rainfall and uneven distribution of water. The Godavari-Manjara Interlink Project will meet the water requirement of Districts like Beed, Latur and Osmanabad of Marathwada region for both drinking as well as irrigation purposes.
- The diverted water of Godavari river will irrigate 95000 ha of land in Marathwada region.
- Lack of surface water due to erratic rainfall results in excess stress on ground water. Due to excess use, the level of ground water is declining. This project will help to reduce the stress on ground water and will effectively increase the ground water level.
- The water scarcity in Marathwada region results in suicide of farmers due to crop failure and economic losses. This project will meet the water requirement for irrigation purposes and will help to stop the suicide of farmers.
- The availability of ample water will increase the irrigation potential of the drought prone area and will ultimately increase the productivity of land.
- The crops in the Marathwada region are mainly rain fed crops. The farmers depend upon rain water for the crop production. This project will inspire farmers to take cash crops and their annual income will increase considerably.
- This project will help to enhance the life of people in this area in social and economical aspects.
- The execution of this project will transform the Dry Hell of Marathwada region into Nandanvan.
CONCLUSION

- This paper presents a brief overall review on the Godavari-Manjara Interlink project. In this project, emphasis has been placed on improving the productivity of agriculture, Water use and water resource management. Our project focuses on system and understanding of water availability, its productivity, allocation, management, and recharge or conservation in Marathwada region. Successful implementation of this project will help to transfer the surplus water of Godavari river towards water deficit areas of Marathwada region.

- Our analysis shows that due to uneven distribution of rainfall there are drought prone conditions in some regions of Godavari basin while there is availability of surplus water in other regions having heavy rainfall values. By studying the hydrology of Godavari basin and Marathwada region it can be concluded that the execution of this project will solve all the water related problems of Marathwada region and we can transfer sufficient amount of water from Godavari river towards Manjara river to tackle with the water scarcity of Beed, Latur and Osmanabad district which suffer through drought conditions almost every year. If water transferred from water abundant region to water deficit region, there would be adequate supply of water for everyone in all parts of the country. It also appears to promote national integration and a fair sharing of the country’s natural water wealth.

- The barriers before the interlinking projects are massive estimated cost of the project, issues related to environmental and ecological impact such as deforestation and soil erosion, rehabilitation of the project-affected people and the interstate river water distribution issues. If all this barriers are overcome by the State and the Central Government, then the Interlinking of rivers will bring the water revolution in India.

REFERENCES

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8. Rockefeller Foundation, Water conflicts across regions and sectors, Case study of Latur city, December 2015


A GIS BASED APPROACH FOR LANDSLIDE HAZARD INDEX ASSESSMENT BY USING AHP

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ABSTRACT Landslide Hazard Index Assessment and susceptibility mapping is a fundamental component of hazard management in decreasing the risk of living with landslides. Landslide susceptibility is defined as the proneness of the terrain to produce slope failures and susceptibility is usually expressed in a cartographic way. The Raigad District in Maharashtra, India is a landslide prone zone because of its own characteristics including the mountainous topography, climate conditions, seismic potential, geology and geomorphology. Landslides have been resulting in damage to roads and villages of this region therefore landslide susceptibility map for this area can save lives and prevent severe damages. In this study, the analytical hierarchy process (AHP) is employed to produce susceptibility maps. For this purpose, eight layers including aspects, raining, elevation, curvature, slope, land cover, distance to stream, and distance to road will be considered. Using this method each layer is broken into smaller factors, then these factors are weighted based on their importance, and finally the last prepared layers are assembled and the final map is generated. Commercial software ArcGIS is used to produce the layer maps which are used in the production of the landslide susceptibility maps.

INDEX TERMS Landslide; Susceptibility map; GIS; hierarchy process Analyticals

24. INTRODUCTION

The study area Raigad District in Maharashtra, India is a landslide prone area because of the following characteristics: The mountainous topography, climate conditions, situating on earthquake prone zone, its geology and geomorphology. As in the previous years, the landslides were resulting in damages to roads and villages of this region; the main objective of this study is to identify the zones with high landslide potential. Doing so, the housing and road authorities can come up with strategic plans to reduce the amount of damages to lives and properties. The study area is covered 7152km², latitude 18.5158, Longitude 73.1822. The climate condition is mountainous and average rain precipitation is very high. Precipitation is measured from 17 stations. The normal annual precipitation ranges between 2200 to 5000mm. The average annual precipitation is 3884mm raining. Landslides and man-made slopes have always involved some form of risk assessment and management. This is often done by the use of engineering judgment by the Geotechnical Engineers or Engineering Geologists in consultation with owners. Slope instability research and susceptibility mapping is a substantial component of hazard management in decreasing the risk of living with landslides. Landslide susceptibility is defined as the potential of the zone to produce slope failures and susceptibility is usually expressed in a cartographic way. Considering that landslides will occur in the future because of the same conditions that produced them in the past, we can use susceptibility assessments to predict the geographical location of future landslides. Landslide occurrence is related to many factors including climate, hydrology, elevation, structure and geomorphic history; nevertheless, it is not always possible to include all aspects of these parameters in susceptibility assessment. Depending on the region conditions, different factors such as elevation, seismic potential, slope and land cover which are considered as layers affect landslide susceptibility zoning.

In order to provide landslide susceptibility maps various methods such as fuzzy logic, statistic methods and Analytic Hierarchy Process (AHP) can be used. One of these methods is the AHP that was used in and. The AHP is a theory of measurement for dealing with quantifiable and intangible criteria has been applied to numerous areas, such as decision theory and conflict resolution. Using this method, each layer used in landslide susceptibility zoning is broken into smaller factors, then these factors are weighted based on their importance, and eventually the prepared layers are assembled and the final map is produced. It is based on three principles: decomposition, comparative judgment and synthesis of priorities. In this method, weight of each layer depends on the judgment of expert, so that the more precise is the judgment, the more compatible is the produced map with reality.
In this study for preparing the susceptibility maps, eight layers including landslide inventory, raining, elevation, seismic potential, slope, land cover, distance to stream, and distance to road are selected. ArcGIS software is used to produce the layer maps which are used in the production of the landslide susceptibility map. It is strongly recommended that landslide zoning be carried out in a GIS-based system so that the zoning can be readily applied for land use planning and can be up-dated as more information is used. The most important factor in determining the scale of susceptibility map is scale of topographic map and initial data. Another effective factor is the purpose of susceptibility map and the area of study region.

25. OBJECTIVES

11) To Identify landslide susceptible zones using geoinformatics.
12) To explore causes of landslide occurrence.
13) To prepare landslide susceptibility maps using the analytical hierarchy process (AHP).
14) To prepare landslide susceptibility maps using the analytical hierarchy process (AHP).

26. DESCRIPTION OF WORK

Layers influencing susceptibility mapping

3.1 ASPECTS

Aspect is accepted as a main landslide conditioning factor, and this parameter is considered in several studies. Some of the meteorological events such as the amount of rainfall, amount of sunshine, and the morphologic structure of the area affect the propensity of landslides. In this study, the aspect map of the study area is produced to show the relationship between aspect and landslides.

3.2 ELEVATION

The elevation of a geographic location is its height above or below a fixed reference point, most commonly a reference geoid, a mathematical model of the Earth's sea level as an equipotential gravitational surface (see Geodetic datum § Vertical datum). Elevation data supports numerous GIS applications ranging from deriving slope and aspect, stream delineation, cut and fill analysis, viewshed analysis, orthorectification of aerial photography or satellite imagery, rendering 3D visualizations, creating relief maps, and for various types of analysis and visualizations. In this study the elevation layer was made by using the digital elevation model.

3.3 SLOPE

The slope is one of the main parameters in the analysis slope stability. Hence, slope is used for landslide susceptibility map as it affects landslide. For preparing landslide susceptibility map, the slope map was divided into five slope categories - very low, low, moderate, high, very high.

3.4 LAND COVER

The effect of land cover on slope stability has been studied as it has vital important. Generally, land cover has effect on strength of slope materials against sliding and control of water content of slope. Roots of the vegetation act as reinforcement and also the land cover absorbs the water of soil and decreases the intensity of landslide. Hence, this parameter has been considered as one of the most important factors in preparing landslide susceptibility maps.

3.5 DISTANCE TO ROAD

The distance to road is one of the main parameters in preparing landslide susceptibility maps. Landslides may occur on the road and on the side of slopes affected by roads. Change of slope due to excavation, additional load, change in hydrology, and drainage may affect the stress state and slope equilibrium. The construction of the road causes change in the nature of topography and causing infiltration of water. For this reason, five different buffer zones are created on the path of the road to determine the effect of the road on the stability of slope.

3.6 DISTANCE TO STREAM

Similar to the effect of the distance to road, landslides may occur on the side of the slopes affected by stream. The closeness of the slope to streams may adversely affect stability of slopes. Stream increases the effect of landslide by eroding the slope and increasing the water level of materials of slope. In this region, proximity to stream is one of the most important factors affecting the occurrence of landslides. The map of distance to the streams was created using a 500-meter buffer zone.
around the major stream canals. Head and shoulders shots of authors that appear at the end of our papers.

### 3.7 RAINING

As the study area is under heavy rainfall and as most of the landslides occur after the heavy rain falls, thus the rainfall is one of the important parameters for making landslide maps. The rate of water infiltration and degree of saturation increases rapidly due to heavy rainfall which leads to occurrence of landslide. In this study 17 precipitation stations were used to consider this parameter. The precipitation directly is related to height.

### 3.8 PLAN CURVATURE

Plan curvature is described as the curvature of a contour line formed by intersecting a horizontal plane with the surface. The influence of plan curvature on the slope erosion processes is the convergence or divergence of water during downhill flow (Ercanoglu and Gokceoglu 2002; Oh and Pradhan 2011). For this reason, this parameter constitutes one of the conditioning factors controlling landslide occurrence (Nefeslioglu et al. 2008b).

#### 4. Results:

In this study, analytical hierarchy process (AHP) have been used for identifying the areas susceptible to landslides in the area Raigad District in Maharashtra, India. For susceptibility analysis, eight landslide conditioning factors were used such as slope degree, aspect, plan curvature, elevation, land cover, distance from rivers, distance from roads, rainfall. AHP was applied to analyze the landslide susceptibility by using mention eight layers. AHP model is conventionally based on a rating system provided by expert opinion.
In fact, expert opinion is very useful in solving complex problems like landslides. Slope instability research and susceptibility mapping is an essential component of hazard management in decreasing the risk of living with landslides. This region is a landslide prone zone because of its own characteristics including the mountainous, topography, climate conditions, located on earthquake zone, geology and geomorphology. The results demonstrated that the active landslide zones had a high correlation to the high and very high susceptibility class of map. Based on this study, it can be stated that the high and very high susceptibility landslide zones identified by the AHP method, can predict potential landslide areas in the reality. The result of this study shows, that when field conditions are properly determined by good proficiency, the AHP method can give more truly results.

5. Conclusions:
By this study landslide susceptible zones can be successfully identified using geo-informatics. All the eight layers play an important role through which causes of landslide occurrence are explored. Suitable mitigative measures can be applied according to the risk identified which will be beneficial to safeguard the lives. Landslide assessment through geo-informatics saves time and money required for actual ground investigation.

6. References:


12. Hamid Reza Pourghasemi, Biswajeet Pradhan, Candan Gokceoglu"Application of fuzzy logic and analytical hierarchy process (AHP) to landslide susceptibility mapping at Haraz watershed, Iran"
Partial Replacement of Concrete Ingredients by Marble Waste and Industrial Waste Water

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³Dept. of Civil Engineering, Pimpri Chinchwad College Of Engineering and Research, Ravet, Pune, Maharashtra, India, 412101
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⁵Dept. of Civil Engineering, Pimpri Chinchwad College Of Engineering and Research, Ravet, Pune, Maharashtra, India, 412101

ABSTRACT The aim of this study is to assess the possibility of utilizing marble waste and industrial waste water as a partial Replacement of Concrete. Marble industry produces a large amount of waste during mining and its processing stage. It has been studied that around 70% of marble waste is produced during marble cutting, which creates a lot of environmental problems when dumped on open land. Our main objective of this study is to effective utilization of marble waste (marble powder and marble as a fine aggregate) by replacement of concrete ingredients (cement and fine aggregate). We also worked on the effect on strength when industrial waste water is mixed into concrete. In this work we have compared strength achieved by the Concrete blocks by addition of waste marble in various proportions. We studied the compressive strength and the behaviour of concrete block under stress. The obtained results of this study indicate that replacing marble waste & industrial waste water found cost reduction in concrete making and compressive strength is also as per IS requirements.

INDEX TERMS Marble Fines, Marble waste Replacement, Concrete, Industrial waste water

7) INTRODUCTION
There are more than 50 different types of minerals and rocks in India and most of it comes from Rajasthan. The state has large deposits of natural rocks which include granite, marbles, sandstone, limestone, slate, quartzite, etc. However it is seen that the process of marble quarrying and its processing generates a large amount of waste in the form of marble powder or as fines. These wastes are then dumped in the open land which creates a lot of environmental as well as health problems. This project contains an experimental investigation of suitability of effective utilization of marble waste by replacing partially with concrete ingredients as well as utilization of industrial waste water into the concrete. With the ever increasing popularity of the marbles of Rajasthan, growing demand for finished and unfinished products, discovery of new marble deposits and growing private and public supports have led to a significant growth in Marble Industry of this State. As a result, number of marble quarries as well as marble processing units has significantly gone up mainly during last one decade. However, whereas there is significant growth in production of finished and unfinished marble products, there is also simultaneous rise in waste generation as well; thereby causing concern towards the deteriorating environmental quality. A wide spread need is being felt to make this industry environmentally sustainable. Previously, studies were carried out in the context of utilization of the marble waste in concrete. In the paper ‘Behaviour of Concrete Using Marble Waste as Coarse Aggregate’ by Sudarshan D. Kore and Ashok Vyas concluded that the workability, compressive strength and permeability increased with increase in substitution of marble aggregate by replacing natural course aggregate by marble aggregate in different percentages by weight of the concrete. In the paper ‘Impact of marble waste as coarse aggregate on properties of lean cement concrete’ they concluded that The workability of all the concrete mix increases with increased percentage of replacement of natural coarse aggregate by marble aggregates. Compressive strength of the concrete shows upward trend till 80% marble used as coarse aggregate in concrete. The permeability of the concrete increases with increase in percentage of replacement of natural coarse aggregate by marble aggregate this is mainly due to presence pores in the concrete.

In this project an investigation is carried out for effective utilization of waste marble powder and fines in the concrete and observes its behavior in the compressive strength. The scope of the project includes cost optimization of concrete and also minimization of cement content used in concrete making. This investigation also checks the effect of using industrial waste water in concrete.

8) Experimental Study
2.1 Materials
An experimental study was performed by prepare of M20 grade concrete mix using partial replacement of cement by marble powder and complete replacement of natural...
crushed sand by marble fines. The cement used is 43 Grade Portland Puzzolona Cement. The naturally available coursed aggregate with nominal size 20mm was used and crushed sand as fine aggregate.

TABLE 2.1
PHYSICAL PROPERTIES OF MATERIALS

<table>
<thead>
<tr>
<th>MATERIALS</th>
<th>SPECIFIC GRAVITY</th>
<th>WATER ABSORPTION</th>
<th>GRADING</th>
</tr>
</thead>
<tbody>
<tr>
<td>COURSE AGGREGATE</td>
<td>2.61</td>
<td>0.54</td>
<td>AS PER TABLE 2 OF IS 383</td>
</tr>
<tr>
<td>CRUSHED SAND</td>
<td>2.66</td>
<td>2.0</td>
<td>ZONE 2 AS PER TABLE 4 OF IS 383</td>
</tr>
<tr>
<td>MARBLE FINES</td>
<td>2.70</td>
<td>0.05</td>
<td>AS PER TABLE 2 OF IS 383</td>
</tr>
</tbody>
</table>

TABLE 2.2
PHYSICAL PROPERTIES OF MATERIALS

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>MARBLE POWDER</th>
<th>MARBLE FINES</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIEVE ANALYSIS</td>
<td>&lt;90 MICRON SIEVE</td>
<td>&lt; 75MM SIEVE</td>
</tr>
<tr>
<td>PICTURE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9) RESULTS & DISCUSSIONS

3.1. RESULTS

As per above procedure concrete testing done and observed result which is given in following table.

TABLE 3.1.
COMPRESSIVE STRENGTH OF CONCRETE

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>3 DAYS (MPA)</th>
<th>7 DAYS (MPA)</th>
<th>28 DAYS (MPA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>REQUIRED STRENGTH (MPA)</td>
<td>8</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td>MIX 1</td>
<td>10.93</td>
<td>16.26</td>
<td>30.71</td>
</tr>
<tr>
<td>MIX 2</td>
<td>7.64</td>
<td>15.77</td>
<td>22.82</td>
</tr>
<tr>
<td>MIX 3</td>
<td>11.33</td>
<td>17.82</td>
<td>22.84</td>
</tr>
<tr>
<td>MIX 4</td>
<td>10.93</td>
<td>16.26</td>
<td>30.71</td>
</tr>
<tr>
<td>MIX 5</td>
<td>8.97</td>
<td>10.67</td>
<td>20.05</td>
</tr>
</tbody>
</table>

![Figure 1. Comparison of Compressive Strength of all Mixes](image)

a. METHODOLOGY

For this experiment, M20 grade concrete mix was prepared with water cement ratio 0.42 and cement content 403.5 Kg/m³. Five sets of mix design were prepared with the trail of using different substituents such as follows:

27. Cement + fine aggregate + course aggregate + water  
28. [Cement(85%)+Marble Powder(15%)] + fine aggregate + course aggregate + water  
29. Cement + Marble Fines + course aggregate + water  
30. Cement + Fine Aggregate + Course aggregate + Industrial Waste Water  
31. [Cement(85%)+marble powder(15%)] + Marble Fines + Course Aggregate + Industrial Waste Water

These concrete were prepared and casted in 150mm concrete mould to take compressive test. After 24 hours these moulds were De-moulded and set for curing in a water tank. The compressive tests were taken in 3days, 7days, 28 days respectively to check the results.
a. **DISCUSSIONS**

From the above results it is observed that by adding all the three ingredients (waste marble powder, marble fines and industrial waste water) at the fixed proportion, we were able to achieve positive compression test results and the this marble waste utilization become cost reduction in in concrete making.

**ACKNOWLEDGMENT**

It gives us a delight for completing our final year civil engineering project ‘An Experimental Investigation on Partial Replacement of Concrete Ingredient by Marble Waste & Industrial Waste Water.’ This Project gave us an insight of the concrete behaviour with the various ingredients and utilization of industrial waste into concrete. This project would not have been possible without our teachers and guide Prof. Satish Pitake. We would also like to thank our Head of Civil Department Dr. Sameer Suwarkar for their encourage words and support in completion of our project. Special thanks to the Principal of Pimpri Chinchwad College of Engineering and Research. Dr. Harish Tiwari for his valuable suggestions and feedbacks. Lastly we like to appreciate my group members who worked together as a team and their contribution for completion of this work.

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9. Govt. of India, Ministry of Micro, Small & Medium Enterprises Development Institute, Jaipur,”STATUS REPORT ON COMMERCIAL UTILIZATION OF MARBLE SLURRY IN RAJASTHAN” (AUG2011)


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Ramkar A.P.1, Ansari U.S2, “Effect of Treated Waste Water on Strength of Concrete”,
https://www.researchgate.net/publication/310241115 (NOV2016)
Sustainable Solution for Disposal of Waste Product (May 2019)

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ABSTRACT Waste materials have become a threat to the environment. These materials should be reused and treated before they are disposed off. Phosphogypsum, one such waste by-product of fertilizers industries possess huge landfill problems all over the world. India produces approximately 25 million phosphogypsum per annum, only a small quantity of which is utilized by famers or cement industries. This research focuses on the maximum use of raw phosphogypsum in cement concrete mixes and analyses the futuristic scope of phosphogypsum in construction industry. Untreated phosphogypsum was used in the preparation of concrete mixes by partially replacing it with cement in 0%, 5%, 10%, 15%, 20% and 25% by weight and finding its compressive strength. The results have been evaluated and it was found that raw phosphogypsum gave unsatisfactory results in compression and thus needs treatment before using them in concrete. The future scope of phosphogypsum in construction industries is huge if the waste is treated and used effectively.

INDEX TERMS phosphogypsum, cement concrete, compressive strength, waste

INTRODUCTION

Waste Materials are a major threat to the environment when not disposed of properly. It is important to reuse and treat such materials which possess certain characteristics and then dispose them off. One of the methods is incorporating wastes in the construction industries by finding their potential strength and utilizing them. This will reduce the burden on nation’s land filling. Phosphogypsum is one such waste by-product obtained from Fertilizer Industries which is then dumped on lands and in seas. Approximately 4.5-5 tons of phosphogypsum is generated per ton of phosphoric acid production (P₂O₅) using wet process [1]. In India, approximately 4.9 million tons of phosphoric acid was produced in the year 2018-19 which accounts for 24.5 million tons of phosphogypsum produced per annum. Commercially, Phosphoric Acid is produced by two methods namely ‘The Wet Process’ and ‘The Thermal Process’. In India, wet process is mostly used for the production of phosphoric acid for making phosphatic fertilizers [2].

The phosphogypsum is mainly calcium sulphate in dihydrate form which also contains impurities such as fluorides, hydroxides, heavy metals, carboneic acids, etc. The general reaction showing production of phosphoric acid and phosphogypsum by wet process is as follows [3]

\[
\text{Ca}_3\text{F}(\text{PO}_4)_{1/3} + 5\text{H}_2\text{SO}_4 + 10\text{H}_2\text{O} \rightarrow 3\text{H}_3\text{PO}_4 + 5\text{CaSO}_4 \cdot 2\text{H}_2\text{O} + \text{HF}
\]

(1)

The weathered phosphogypsum can be used as a retarder in place of natural phosphogypsum for Portland cement [4]. Up to 75% of waste phosphogypsum is simply prepared into non fired bricks only with small quantities of river sand which is a cost effective way to recycle the waste [5]. The influence of phosphogypsum impurities is studied and its effect on setting time and compressive strength of mortar and concrete are presented along with various methods to beneficiate the PG has been postulated [6]. Phosphogypsum based slag aggregate was substituted for coarse aggregate in Portland cement and was tested for compressive, splitting tensile and flexural strength by using in concrete. The results indicated that slag aggregate performed well as a coarse aggregate in Portland cement concrete and should perform satisfactorily in highway pavement system [7]. This research mainly investigated the effect on compressive strength of the concrete in presence of waste phosphogypsum when added with different percent by weight of cement. Only raw phosphogypsum was used to find the maximum percentage of the phosphogypsum that can be used in cement concrete and thus possess less risk on landfills. The concrete strength was designed for 20 MPa and 40 MPa and the calculated quantity of cement was replaced by phosphogypsum at 0%, 5%, 10%, 15%, 20%, and 25% in terms of weight.

MATERIALS AND PREPARATION OF SPECIMEN

A. Physical Properties of Phosphogypsum

Phosphogypsum is a grey coloured, damped, fine grained powder with a maximum size range between 0.5 mm to 1 mm [2]. Phosphogypsum has properties similar to natural gypsum. The density of particles ranges from 2.27 to 2.40 g cm⁻³. The free water content of phosphogypsum mainly depends on nature of rock, draining time of the stack and local meteorological conditions [8]. Usually free moisture is generated per ton of phosphoric acid production (P₂O₅). In India, approximately 4.9 million tons of phosphoric acid was produced in the year 2018-19 which accounts for 24.5 million tons of phosphogypsum produced per annum. Commercially, Phosphoric Acid is produced by two methods namely ‘The Wet Process’ and ‘The Thermal Process’. In India, wet process is mostly used for the production of phosphoric acid for making phosphatic fertilizers [2].

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\]

(1)
content between 25-30% exists in the gypsum cake after drying [1].

B. Chemical Properties of Phosphogypsum
Calcium and \( \text{SO}_4^{2-} \) are major constituents of phosphogypsum. Phosphogypsum is acidic in nature due to presence of various residual acids such as Phosphoric, Sulphuric and Fluoride acids [8]. Primary phosphogypsum may consist of calcium sulphate dihydrate with small amounts of silica, usually as quartz and unreacted phosphate rock, radioactive material (like radium, uranium), heavy metals namely arsenic, cadmium, chromium, mercury and fluoride. The concentration of the metals depends on the composition of the phosphate rock [2].

10) PREPARATION OF SPECIMEN

Ordinary Portland cement, raw phosphogypsum, crushed stone (fine and coarse) was used to prepare concrete specimens in this research. The fineness modulus of sand and coarse aggregate was 2.9 and 6.9 respectively. The aggregate was washed and dried to remove any dust, clay or organic materials. Potable water was used for mixing of concrete. The phosphogypsum sample was collected from Paradeep Phosphates Ltd, Paradeep, Odissa. The industry is one of the huge producers of Phosphatic fertilizers in India and eventually of phosphogypsum. Cement concrete blocks of strength 20 MPa and 40 MPa were prepared to check the effects of phosphogypsum compressive strength of concrete.

The quantities of ingredients for concrete mix was calculated as per IS 10262:2009 (Guidelines for Concrete Mix Design Proportioning) and IS 456:2000 (Workability, Durability and Concrete Mix Proportioning). The specimens are tested for compressive strength according to IS 516:1959.

RESULTS AND DISCUSSION

A. Compressive Strength of Concrete (20 MPa)
The test results of 7 days and 28 days compressive strength for 20 MPa are given in Figs. 2 & 3 respectively. The result shows that the compressive strength obtained does not decrease below 50% of the expected when the percentage of phosphogypsum is kept between 5-15%. Adding more than 15% phosphogypsum reduces the strength of concrete significantly. In any case the compressive strength does not seem to increase with the addition of waste phosphogypsum directly into the concrete.

B. Compressive Strength of Concrete (40 MPa)
The test results of 7 days and 28 days compressive strength for 40 MPa are given in Figs. 4 & 5 respectively. The result of M20 and M40 gives almost similar interpretations. The strength of concrete decreases with addition of waste phosphogypsum but the results are more drastic when percentage exceeds 15%.
**SCOPE OF PHOSPHOGYPSUM IN CONSTRUCTION INDUSTRY**

These Concrete paving blocks are also the ideal materials on the footpaths for easy laying, better look and finish. Within a span of 3 years these block become unserviceable due to rapid deterioration occurred on new pavers[9].

The paving blocks can become a potential source of utilizing the waste phosphogypsum in its manufacturing. The minimum strength requirement of paving blocks are 30 MPa, which can be obtained if the phosphogypsum based concrete is designed for strength of 40 MPa. The waste gets utilized and the cement content is reduced which makes it an economical product, hence posing less burden on landfills.

**CONCLUSION**

PPL at Odissa is one of the leading sources of phosphogypsum production in India. The industry occasionally sells the waste product at low prices to the local farmers who use it in soil amendment. However, the waste phosphogypsum which is in the form of slurry is mainly stored in surge tanks as per the guidelines of Central Pollution Control Board, India. The addition of 5-15% of raw phosphogypsum in concrete is an acceptable approach if the concrete is used in manufacturing of paver blocks, bricks, etc. To obtain better results, phosphogypsum needs to be treated chemically and use it as a substitute of cement in concrete works. A lot of research work has been carried on the use of phosphogypsum and from this research, it can be concluded that raw phosphogypsum should be treated before it is used as a replacement of cement. Phosphogypsum when used effectively provides an economical approach to the construction industry while carrying the benefit of sustainable utilization of industrial waste product.

**ACKNOWLEDGMENT**

The laboratory support provided by Pimpri Chinchwad College of Engineering & Research, Pune and Dr. Sameer Sawarkar of Department of Civil Engineering, PCCOE&R are gratefully acknowledged. Thanks also extended to the authorities of Paradeep Phosphates Ltd, Odissa for providing the material support.

**REFERENCES**


EFFECT OF DEM RESOLUTION ON ESTIMATION OF UNIVERSAL SOIL LOSS EQUATION LS FACTOR (May 2020)

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³Dept. of Civil Engineering, Pimpri Chinchwad College Of Engineering and Research, Ravet, Pune, Maharashtra, India, 412101
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ABSTRACT
Better life and human development leads to exploration of a vast amount of forest area and thus environmental degradation becomes common. Changes in land uses contribute to soil erosion. LS factor plays an important role in estimating soil erosion risk using empirical models such as RUSLE (Revised Universal Soil Loss Equation). The study was carried out in Raigad district of Maharashtra, India to estimate the impact of varying DEM resolutions on LS factor values. The aim to study was to estimate the impact of various computational flow accumulation as well as varying slope exponents on LS factor values. Slope Gradient and Slope Length factors are the commonly used parameters of USLE (Universal Soil Loss Equation) to predict soil erosion. These factors are plucked out from the Digital Elevation Model (DEM). Thus the DEM grid size will influence topographic factors and therefore soil loss calculation. Different DEM resolutions such as SRTM (30m), SRTM (90m), and GTOPO (900m) were used for comparison.

INDEX TERMS
LS factor, DEM resolution, QGIS, ArcGIS, SRTM, GTOPO

1. INTRODUCTION
Cutting down the forest areas for development of new areas of housing, agriculture, recreation, mining and industrial activities has increased. Extensive deforestation for development of new areas has resulted in disturbance of the ecological environment. It has been acknowledged that the harmful effects of widespread soil erosion such as soil degradation, agricultural production, water quality, hydrological systems, and environments are serious problems for human sustainability (Lal, 1998). In this constantly changing environment, the availability and distribution of water varies with space and time. It is necessary to collect the data with high accuracy but practically it is not possible. So in such cases, remote sensing and GIS plays an important role for collecting accurate and correctly formatted data. The study carried out by Shuttle Radar Topography Mission (SRTM) in February 2000 has delivered near global topographic data that has been used for multipurpose and by many fields of Earth Science (Mukul Manas et al., 2015). Terrain analysis is defined as the process of describing the terrain with respect to roughness, altitude, slope, etc. This type of analysis is useful in determining land suitability for agriculture, construction of roads, designing irrigation schemes, and other land use. And also plays an important role while selecting a site. The terrain parameters such as slope steepness and slope gradient will be computed from DEM data using QGIS (Quantum Geographic Information System). QGIS is a free and open source platform desktop that supports viewing, editing, and analysis of geospatial data. The objective is to capture the geomorphological changes with greater precision and estimate soil erosion with high resolution DEM. DEM is a 3D computer graphic representation of the terrain surface. DEMs are generally used in the Geographic Information System (GIS). Various DEMs such as SRTM (30m), SRTM (90m), and GTOPO (900m) are used to compare the difference in computing the topographical LS factors. Hence, the aim of this study was to determine soil erosion using Revised Universal Soil Loss Equation (RUSLE). In flow accumulation, the accumulated flow is calculated as the accumulated weights of all cells flowing into each downslope cell in the output raster. Output cells with a high flow accumulation are areas of concerned flows and can be used to identify stream channel. Calculation of flow accumulation is very important measure for many hydrological and topographical analyses.

MATERIALS AND METHODS:

2.1 STUDY AREA:
Study area is Raigad District in the state of Maharashtra, India. Total area of the composed region is 7152 sq. m. Raigad district is one of the four districts which lies along the western coast of the Maharashtra state. It is located between north latitude 17°51′00″ and 19°08′00″ and east longitudes 72°50′00″ and 73°40′00″ and is bounded by Thane in the north, Ratnagiri in the south, Pune in the east and Arabian sea at the west having a boundary of length 250km.
Acquisition of the DEM depends upon the resolution or the grid size. The data required for DEM resolutions such as SRTM 30m and GTOPO 900m are obtained from USGS Earth Explorer and for SRTM 90m data is obtained from Open Topography through internet explorer. The concerned area is plotted using the coordinates creating the polygon. Then this is downloaded in the form of tiff format as Shape File. Then the data is processed through QGIS or ArcGIS software to obtain required DEM resolutions.

### 2.2 DEPM DATA ACQUISITION:

<table>
<thead>
<tr>
<th>DEM</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRTM 30m</td>
<td>USGS</td>
</tr>
<tr>
<td>SRTM 90m</td>
<td>Open Topography</td>
</tr>
<tr>
<td>GTOPO 900m</td>
<td>USGS</td>
</tr>
</tbody>
</table>

Table 2.2.1 Sources of DEM

### 2.3 METHODOLOGY:

The software used for the processing of the acquired data from earth explorer is QGIS or ArcGIS. The software contains a toolbox for performing and processing of the image. The fill operation is performed in order to fill the sinks. The L factor is calculated using the flow accumulation tool in the software whereas slope exponent is calculated separately. LS factor is calculated with help of raster calculator, this uses the two layers created earlier. Now the mean values, deviation values are compared for the analysis purpose and variations are studied.

The Length and slope factor was calculated through a series of equation. The slope length (L) is calculated as given by (Wischmeier & Smith, 1978)

\[
L = \left(\frac{X}{22.13}\right)^m \quad \ldots (1)
\]

Where,

22.13 is the RUSLE plot length (metres),

\(X\) = slope length (m)

\(S\) = slope gradient (%)

\(m\) = variable slope exponent

\[
\begin{array}{|c|c|}
\hline
m \text{ value} & S \text{ value} \\
\hline
0.50 & > 5 \\
0.40 & 3-5 \\
0.30 & 1-3 \\
0.20 & <1 \\
\hline
\end{array}
\]

Source: Ministry of Natural Resources and Environment, Malaysia(2010)

Table 2.3.1 Values of Slope Exponent

The slope steepness (S) factor is calculated as given by (McCool at el., 1989)

\[
S = 10.8 \sin \phi + 0.03 \quad \phi < 9\% \quad \ldots (2)
\]

\[
S = 16.8 \sin \phi - 0.5 \quad \phi \geq 9\% \quad \ldots (3)
\]

LS factor is also compared by values of constant slope exponent (m) and also spatially distributed slope exponent. Also by analysis two algorithms to determine the flow direction i.e. single flow direction and multiple flow direction. The LS factors of these two algorithm are compared which are given by (McCool at el., 1989) and (Desmet & Govers, 1996).

### 3 RESULTS AND DISCUSSION:

For each DEM, LS factor are calculated using Slope Length (L) factor and Slope Steepness (S) factor equation. LS factor is calculated on the basis of variable slope exponent (m) which varies from 0.2 to 0.5 in steep terrain. Calculation of slope length (L) factor and slope steepness (S) factor showed that the LS factor in each DEM varied from 0 to 100. The L and S factors in RUSLE showed the effect of topography on erosion. The L factor, S factor and flow accumulation helps to make better comparison of DEM resolutions.
Fig 3.1 Slope of SRTM 30m  Fig 3.2 Flow Accumulation of SRTM 30m  Fig 3.3 LS Factor of SRTM 30m

Fig 3.4 Slope of SRTM 90m  Fig 3.5 Flow Accumulation of SRTM 90m  Fig 3.6 LS Factor of SRTM 90m

Fig 3.7 SRTM of GTOPO900m  Fig 3.8 Flow Accumulation of GTOPO900m  Fig 3.9 LS Factor GTOPO900m
<table>
<thead>
<tr>
<th>Parameter</th>
<th>SRTM 30m</th>
<th>SRTM 90m</th>
<th>GTOPO 900 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
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<td>0</td>
<td>0</td>
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<tr>
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<td>SD</td>
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<td>Coefficient of variation</td>
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</table>

Table 3.1 LS factor statistics with slope exponent constant

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SRTM 30m</th>
<th>SRTM 90m</th>
<th>GTOPO 900 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Max</td>
<td>79.62</td>
<td>64.19</td>
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<tr>
<td>SD</td>
<td>79.62</td>
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<td>19.93</td>
</tr>
<tr>
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</table>

Table 3.2 LS factor statistic with distributed Slope value

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SRTM 30m</th>
<th>SRTM 90m</th>
<th>GTOPO 900 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Max</td>
<td>18000000</td>
<td>228334</td>
<td>2195</td>
</tr>
<tr>
<td>Mean</td>
<td>900000</td>
<td>114167</td>
<td>1097</td>
</tr>
<tr>
<td>SD</td>
<td>18000000</td>
<td>228334</td>
<td>2195</td>
</tr>
<tr>
<td>Coefficient of variation</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 3.3 LS factor statistic with flow accumulation

4. CONCLUSIONS:
The study methodically explores the effect of DEM grid size on determining slope length, slope steepness, flow algorithms and LS factor. DEM of SRTM 30m gives high resolution as compared to resolutions of SRTM 90m and GTOPO 900m. The slope length increases with increase in DEM grid size whereas slope steepness decreases with increase in DEM grid size. The LS factor computed using L factor, S factor and flow accumulation helps in determining the level of soil loss through RUSLE model. The potential erosion in the study depends upon the topographic LS factor as the major factor. This study can be used as baseline information for decision makers to develop regional planning for the study area.

ACKNOWLEDGMENT
It gives me an immense pleasure to submit this project report on “EFFECT OF DEM RESOLUTION OF UNIVERSAL LOSS EQUATION ON LS FACTOR.” We tried our level best to represent this topic into compact and to the point framework.
Wish to express our sincere thanks with profound gratitude to our project guide Prof. S.S. BOBADE for his valuable guidance and constant encouragement without which it would have been impossible for us to present and complete this project successfully.

We would like to extend our sincere and true thanks to our Head of Department Dr. Sameer Sawarkar and principal Dr. H.U. Tiwari as well as all the staff members for impairing us the best of their knowledge and guidance.

Last but not the least; We also thank all our beloved friends for their assistance and help.

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ECONOMICAL AND ECO- FEASIBLE METHOD OF SLAB CURING USING CURING PAD
Anand B Kudoli (anand.kudoli@pccoer.in)¹, Suraj S Alhat², Rohit S Borhade³, Rohit B Jawale⁴, Shubham V Mali⁵
Department of Civil Engineering, Pimpri Chinchwad College of engineering and research, Ravet – Pune 412101

ABSTRACT:
Efficient uninterrupted curing is a key to quality concrete. Proper curing of concrete is crucial to obtain design strength and maximum durability considering the cost of curing. Curing is designed primarily to keep the concrete moist, by preventing the loss of moisture from the concrete during the period in which it gains strength. Due to rising problems of scarcity of water and expensive conventional methods of curing, it had become necessary to build-up a new method for concrete curing. This paper represents the experimental work related to a newly developed, effective and economical method of slab curing. This method consists of a technology namely ‘Curing Pad’ that not only absorbs and retains water for an extended period of time but also reduces evaporation losses. Concrete pad consists of 3 layers. The top layer is of a reflector material that reduces evaporation losses. The middle layer comprises of an absorbent material that stores and transmits water to the concrete slab. Bottom layer is binding or packing layer that holds all three layers together. Various tests are performed to check the durability of Curing Pad as well as its performance on concrete slab. These test results are compared to those of ponding method of slab curing.

INDEX TERMS : strength, scarcity of water.

1. INTRODUCTION
Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Raw materials used in cement are heated to a temperature up to 1450 °C and then cooled. This heat gets stored in the cement and on the addition of water it reacts with the water forming an exothermic reaction which evolves heat. Heat of hydration induces thermal gradient due to higher rate of loss of heat from outer surface than from inner core. This thermal gradient causes cracking in concrete due to non-uniform expansion of concrete within the body.

Curing is the process of controlling the rate and extent of moisture loss from concrete during cement hydration. It may be either after it has been placed in position (or during the manufacture of concrete products), thereby providing time for the hydration of the cement to occur. Since the hydration of cement does take time – days, and even weeks rather than hours – curing must be undertaken for a reasonable period of time if the concrete is to achieve its potential strength and durability. Curing may also encompass the control of temperature since this affects the rate at which cement 2 hydrates. The curing period may depend on the properties required of the concrete, the purpose for which it is to be used, and the ambient conditions, i.e. the temperature and relative humidity of the surrounding atmosphere. Curing is designed primarily to keep the concrete moist, by preventing the loss of moisture from the concrete during the period in which it is gaining strength. Curing may be applied in a number of ways and the most appropriate means of curing may be dictated by the site or the construction method.

2. RESEARCH METHODOLOGY
Various construction sites were visited to inspect the traditional way of curing used for column and slabs. We found that gunny bags and ponding method used for column and slabs respectively. This type of curing method which is used since last years. Data was collected pertaining to available methodologies and applications of ponding method for curing of slab. The collected data were used for separation of traditional and new method of curing. On the basis of data we have decided to make curing pad of three layers. Based on collected data analysis was made to find out the most suitable materials for: -
• Upper Layer: - To prevent evaporation losses
• Middle Layer: - Material having capacity to absorb and hold water
• Bottom Layer: - Durable material to transmit water from middle layer to concrete slab below. This three layers in one pad which will help to keep the surface moist for long time.

3. ANAYASIS
1. Compressive strength test for m20 cubes in which 18 blocks were casted to check against 3, 7, 28days. 9 blocks Immersed in curing tank and others cured by using curing pads. Test results are in following table:

<table>
<thead>
<tr>
<th>Readings</th>
<th>3 Days (mpa)</th>
<th>7 Days (mpa)</th>
<th>28 Days (mpa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type-I PAD</td>
<td>9.5</td>
<td>12.24</td>
<td>23.22</td>
</tr>
<tr>
<td>Type-II PAD</td>
<td>11.45</td>
<td>17.45</td>
<td>24.35</td>
</tr>
<tr>
<td>Immersed in water</td>
<td>13.72</td>
<td>18.45</td>
<td>26.4</td>
</tr>
</tbody>
</table>

Table 1. Strength Results
2. Workability of curing pad to check against wear and tear of pads when come in contact with rough surface of slab.
3. This pads are cost effective method of curing it requires 5 rupees cost per sq.ft.
4. Curing pad absorb the water 3 liters (size 2x3 ft.) and holds the water up to 7 days for normal surface. For freshly cured slab, pad holds the water 1 day and surface keeps wet. For fresh slab first 7 days we need to sprinkled water after that alternately curing can be done.

Test results of absorption of water:

<table>
<thead>
<tr>
<th>Readings</th>
<th>Type-I PAD</th>
<th>Type-II PAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Weight</td>
<td>1090</td>
<td>960</td>
</tr>
<tr>
<td>Weight after adding water</td>
<td>4820</td>
<td>4760</td>
</tr>
<tr>
<td>Weight after 1 day</td>
<td>3760</td>
<td>3650</td>
</tr>
<tr>
<td>Weight after 3 Day</td>
<td>2830</td>
<td>2610</td>
</tr>
<tr>
<td>Weight after 7 Day</td>
<td>1120</td>
<td>990</td>
</tr>
</tbody>
</table>

4. CONCLUSION
Based on the research results presented, the following conclusions were drawn:
1. The concrete cubes cured in water tank and those cured by curing pads showed similarity in their relative compressive strength development.
2. The use of the following curing methods: Immersion in lime water; covering with curing pads; and immersion in water, should be limited to the 28-day curing period.
3. Strength of concrete by using curing pads is more than the conventional ponding method.
4. It is a one type investment that is only buying cost of pads which is useful for different floors.
5. Curing pads helps to reduce amount of water for curing.
6. It is effective, environmental friendly and economical method of curing of slab.

5. ACKNOWLEDGMENT
It gives us an immense pleasure in submitting our research paper on “Economical and eco-feasible method of slab curing using curing pad”. We take this opportunity to show panegyrics and thanks to our guide Prof. A. B. Kudoli and Coordinator Prof. S. Pitke whose suggestions helps us a lot throughout the duration of our efforts on research. We are also indebted to Dr. S. S. Sawarkar, Head of the Department who was constant source of inspiration to us during completion of this research work. We would like to extend my special thanks to the Principal, Dr. H. U. Tiwari for his assistance and providing helpful suggestion.

We are thankful to all teaching and non-teaching staff members of Civil Engineering Department for their help and co-operation during the course of this work.

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6.3 I.S. Code
Faster than Speed of light: time travel to the future and the past (based on Special Relativity)

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ABSTRACT:
In this paper the time dilation topic and further more analysis on time travel is discussed. As we know, that special relativity (time dilation) provides us a way to travel to the future. But as we can see that time dilation and special relativity provides us the speed less than the speed of light. In this paper the effects on time after exceeding the speed of light is discussed that how we can get speed more than the speed of light in special relativity and can theoretically travel to past also. (these are the effects and an approach to see what happens to time after travelling at a speed more than the speed of light.)

INDEX TERMS: speed of light, time travel

1. INTRODUCTION
As we can see from special relativity, a paper published by Albert Einstein in 1905, the time dilation provides us the effects on time after approaching a speed close to speed of light. The special relativity is based on two postulates:
I. The laws of physics are invariant in all inertial frames of reference, and
II. The speed of light in vacuum is the same for all observers, regardless of the motion of the light source or observer.

\[ t' = \gamma (t - vx/c^2) \]
\[ x' = \gamma (x - vt) \]
\[ y' = y \]
\[ z' = z, \]

The equations above are the equations of Lorentz Transformation for moving bodies. It shows how time and position changes if the reference point changes i.e. two observers seeing an event from different reference frames.

The first equation tells us about the effect on time for a moving observer with respect to the observer on the ground.

But if we see that special relativity allows us to travel at a speed less than the speed of light. By solving these equations further, we can see that special relativity’s time dilation can be used to travel more than the speed of light and also a modified version can lead us to the past travel.

We will solve this by taking the help of twin paradox experiment based on time dilation effect. (Reference: Wikipedia-twin paradox)

Consider a space ship traveling from Earth to the nearest star system: a distance \( d = 4 \) light years away, at a speed \( v = 0.8c \) (i.e., 80 percent of the speed of light).

To make the numbers easy, the ship is assumed to attain full speed in a negligible time upon departure (even though it would actually take close to a year accelerating at 1 g to get up to speed). Similarly, at the end of the outgoing trip, the change in direction needed to start the return trip is assumed to occur in a negligible time.

The parties will observe the situation as follows:

Earth perspective
The Earth-based mission control reasons about the journey this way: the round trip will take \( t = 2d/v = 10 \) years in Earth time (i.e. everybody on Earth will be 10 years older when the ship returns). The amount of time as measured on the ship’s clocks and the aging of the travelers during their trip will be reduced by the factor \( \epsilon = \sqrt{1 - v^2/c^2} \), the reciprocal of the Lorentz factor (time dilation). In this case \( \epsilon = 0.6 \) and the travelers will have aged only \( 0.6 \times 10 = 6 \) years when they return.

Travelers’ perspective
The ship’s crew members also calculate the particulars of their trip from their perspective. They know that the distant star system and the Earth are moving relative to the ship at speed \( v \) during their trip. The amount of time as measured on the ship’s clocks and the aging of the travelers during their trip will be reduced by the factor \( \epsilon = \sqrt{1 - v^2/c^2} \), the reciprocal of the Lorentz factor (time dilation). In this case \( \epsilon = 0.6 \) and the travelers will have aged only \( 0.6 \times 10 = 6 \) years when they return.

Their calculations show that they will arrive home having aged 6 years. The travelers’ final calculation about their aging is in complete agreement with his
calculations of those on Earth, though they experience the trip quite differently from those who stay at home.

**Conclusion**

No matter what method they use to predict the clock readings, everybody will agree about them. If twins are born on the day the ship leaves, and one goes on the journey while the other stays on Earth, they will meet again when the traveler is 6 years old and the stay-at-home twin is 10 years old.

### 2. SOLUTIONS FOR SPEED MORE THAN THE SPEED OF LIGHT

In the Lorentz factor $\varepsilon = \sqrt{1 - \frac{v^2}{c^2}}$ if we solve further then we will get a new modified equation as $\varepsilon = \sqrt{\frac{c^2 - v^2}{c^2}}$, which can be further solved as $\varepsilon = \sqrt{\frac{(c+v)(v')}{{c'}^2}}$, where we can see that the term $(c + v)$ is the speed more than the speed of light.

And if we take the above example data and solve it at a speed of $4 \times 10^8 \text{ m/s}$, here $v=2.333c$. Now the time for the traveler to return from the space trip at the same distance of $d=4$ light years will be $t_m = t_s \sqrt{\frac{(c+v)(v')}{{c'}^2}}$, and thus $t_m = 5.6\text{ yrs}$ and $t_s = 3.42$ yrs.

Now if we take the speed as $2c+v=7 \times 10^8 \text{ m/s}$ where $v=2.333c$, so the time for the traveler to return from space trip for the same distance $d=4$ light yrs will be $t_m = t_s \sqrt{\frac{(2c+v)(v')}{{c'}^2}}$, and thus $t_m = 6.7$ which is greater than the time for the observer on the ground and hence the past travel is possible but at a speed more than $2c$.

And the general equation of the factor now termed as

$$\alpha = \sqrt{\frac{(2^n c + v)(v')}{{c'}^2}}$$

Where $c=$ speed of light
$v=$traveling speed
$v’=2^n c - v$
$n=0,1,2,3,...n$

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Assessment of Compressive strength of conventional concrete by using Self healing agent
Ramesh Khatal\(^1\), Pravin choudhari\(^2\), Harshad sabale\(^3\), Omkar Raut\(^4\), Rahul Patil\(^5\)

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ABSTRACT:
Crack formation is very common phenomenon in concrete structure which allows the water and different type of chemical into the concrete through the cracks and decreases durability and strength. Self-healing mechanism in the concrete which helps to repair the cracks by producing calcium carbonate crystals which block the micro cracks and pores in the concrete. Bacillus pasteurii, Bacillus subtilis and B. sphaericus, Bacillus megaterium which are mainly used for the experiments by different researchers for their study. The selection of the bacteria was according to their survival in the alkaline environment. The condition of growth is different for different types of bacteria. For the growth, bacteria were put in a medium containing different chemical at a particular temperature and for a particular time period. In this study Self-Healing agents such as Bacillus Sphaericus used Bacteria is mixed in concrete with calcium lactate. Bacteria used in proportion of 10, 20, 30 ml/liter and calcium lactate 10g/liter water. A Comparison study is made with this concrete subjected to compressive strength of normal concrete and Bacterial concrete.

INDEX TERMS : Bacillus sphaericus, Bacterial Concrete, Calcium lactate, Self healing agents.

1) Introduction
Concrete is the most widely used man made construction material. Some of major forms of environmental attack are chlorides and sulphate that lead to corrosion of reinforcement and subsequent reduction in strength, serviceability and aesthetics of the structure. Crack formation is a typical phenomenon related to durability. Percolation of crack may lead to leakage problems, causing deterioration of the concrete matrix or corrosion of embedded steel reinforcement. [17]. So to find solution for this recent years a bacteria-based self-healing concrete is being developed in order to extend the service life this called Self healing concrete or Bacterial concrete.[11]

II. Background of Self Healing concrete
Bacteria are added to the concrete mix to enhance the strength and also it acts as an excellent self-healing agent. It consists of cement, aggregate, sand, Bacteria, Calcium lactate. Self-healing concrete is a bacterial remediation technique surpasses other techniques it is bio-based, eco-friendly, cost-effective and durable.
lactate is converted to insoluble limestone. The insoluble limestone starts to harden.

\[ CaO + H_2O \rightarrow Ca(OH)_2 \]

\[ Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O \]

Fig 2. Chemical process of Self-healing

Bacteria are microscopic, single-celled organisms that thrive in diverse environments. These organisms can live in soil, the ocean and inside the human gut.

B. Bacteria used in Self-healing concrete

From various Researches carried on self-healing concrete researchers concluded that Bacillus family bacteria is used to make self-healing concrete. Following are the Bacteria used in Self-healing concrete are Bacillus sphaericus, Bacillus pasteurii, Bacillus megaterium, Bacillus subtilis, Bacillus aerius, Sporosarcina pasteurii, AKKR5, Shewanella Species, Bacillus flexus, etc.

C. Preparation of Bacterial Concrete

Bacterial concrete can be prepared in two ways-

- By direct application

Bacterial spores and calcium lactate is added into concrete directly when mixing of concrete is done. When Crack occurred water comes in contact with this bacterium, they germinate and feed on calcium lactate and produces limestone. Thus sealing the cracks.

2) By encapsulation in lightweight concrete

By encapsulation method the bacteria and its food i.e. calcium lactate, are placed inside treated clay pellets and concrete is prepared. About 6% of the clay pellets are added for making bacterial concrete. [8]

When concrete structures are made with Bacterial concrete, when the crack occurs in the structure and clay pellets are broken and the bacteria germinate and eat down the calcium lactate and produce limestone, which hardens and thus sealing the crack. Minor cracks about 0.5mm width can be treated by using bacterial concrete.

Bacillus sphaericus

Bacillus sphaericus is an obligate aerobe bacterium, gram-positive bacteria, rod-shaped used as a larvicide for mosquito control. It forms spherical endospores. Rods, 0.6 to 1.0 by 1.0 to 7.0 microns, with ends rounded or pointed, occurring singly or in short chains. Motile. Gram-variable, often Gram-negative with Gram-positive granules. Spores, 0.7 to 1.2 microns in diameter, round, terminal to sub terminal. Spore wall usually thick and easily stained. Remnants of the sporangium often adhere making the surface rough and spiny. Immature spores sometimes ellipsoidal, becoming round. Found mainly in soil. Maintaining medium- nutrient agar, nutrient broth.

Bacillus Sphaericus possesses maximum urease activity and increases the strength of concrete. Therefore, is suitable to be used for bacterial calcite precipitation in concrete. [1,5,6,7]

III. Methodology

In this Research paper initial investigation on Self-healing concrete is done on M20 grade of concrete. The main aim in this project is to compare the hardened properties of normal water concrete, Bacterial concrete. The material tests required to obtain the mix design of concrete were carried out in the laboratory. The mix design for M20 concrete is obtained using the IS Standard method of design. The material used are: Cement used is Birla super OPC 53
grade, River Sand and 20mm Coarse aggregates, 
Bacillus sphaericus Bacteria with 10,20,30 ml/liter, 
Calcium lactate 10gm/liter. The experimental 
investigations carried out on normal and bacterial 
concrete are: Cubic compressive strength. The 
strengths of Bacterial concrete are compared with the 
strengths of normal water concrete. The cubic 
compressive strengths are compared for 7 days, 14 
days and 28 days curing period. In this research work 
36 cubes were casted.

IV. Experimental procedure
A. Materials
1. Cement
Cement is a binder material, ordinary Portland 
cement (OPC) of 53 grade (Birla super brand) was 
used. The physical and chemical properties of 
cement are as per IS12269:1987[21].

2. Fine aggregate
River sand passing through 4.75mm IS sieve and 
confirming to zone-2 of IS383:1987[22] was used. 
The specific gravity was found to be 2.78.

3. Coarse aggregate
The coarse aggregate used in this work was was of 
20 mm down nominal size. The crushed angular 
shaped coarse aggregate was obtained from the local 
crushing plants. It has specific gravity of 2.94.

4. Water
Potable water is used for conventional and bacterial 
concrete.[23]

5. Bacillus sphaericus
The Microbial culture of Bacillus sphaericus was 
obtained in Freeze dried form in ampoules under the 
code NCIM 2478 (ATCC14557, DSM28) from 
National Collection of Industrial Microorganisms. 
Prescribed medium by NCIM is Nutrient agar 
(solid), Nutrient broth (Liquid).

1) For 1000ml of distilled water 13g of nutrient broth 
was taken in a conical flask. Then the conical flask 
should be cotton plugged.
2) Then the broth is kept in an autoclave for 20 mi at 
120 deg centigrade.
3) Then the flask was taken out and it should be 
cooled to room temperature.
4) Use laminar air flow chamber for inoculating the 
broth without any contamination.
5) Before using the laminar air flow chamber clean 
the chamber with ethanol.
6) Then after revived culture was taken and it is 
mixed with the broth.
7) Then keep the conical flask in the incubator at 30 
deg centigrade for 24 hrs.

Fig 6.Bacterial culture

6. Calcium Lactate
Calcium lactate is a white crystalline salt made by 
the action of lactic acid on calcium carbonate. It is 
created by the reaction of lactic acid with calcium 
carbonate or calcium hydroxide. The chemical 
formula of Calcium lactate is $\text{CaHL} \cdot \text{CaO} \cdot 5\text{H}_2\text{O}$.
Manufactured by Analab fine chemicals, Mumbai. 
We have used calcium lactate in our research in the 
Quantity 10 gram/liter.

B. Mix Design

For this Research, the concrete M20 Grade for the 
samples was used. The M20 grade mix design of 
concrete is taken as per IS10262-2009 [24].it shown 
in table 1.

<table>
<thead>
<tr>
<th>Table 1 Mix Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement (kg)</td>
</tr>
<tr>
<td>426</td>
</tr>
</tbody>
</table>
The proportion of mix design is 1:1.64:3.

C. Tests conducted on Concrete

1) Compressive strength test

This test was conducted as per IS 516-1959 [25]. The cube mould of size 150mm × 150mm × 150mm, conforming to IS: 10086 – 1982 were used to find the compressive strength of concrete. Specimens were placed on the bearing surface of CTM with the capacity of 200 kN without the eccentricity and a uniform rate on loading is 140 kg/cm² per minute was applied until the failure of the cube. The maximum load was noted and the compressive strength was calculated. The compression strength in N/mm²=P/A. The tests were performed at a curing age of 7, 14 and 28 days. Total 36 cubes, with three specimens for four different batches were made for testing at each selected age.

V. Result and Discussions

A. Compressive test results

In the compressive strength test, three cubes constituted of one sample. Total 36 cubes were tested the compressive strength test is performed as described in section. The Table show the 7th, 14th and 28th day Compressive strength test results.

<table>
<thead>
<tr>
<th>INDEX</th>
<th>7th Day</th>
<th>14th Day</th>
<th>28th Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal concrete</td>
<td>13.15</td>
<td>15.2</td>
<td>22</td>
</tr>
<tr>
<td>BCNW 10</td>
<td>13.52</td>
<td>18.42</td>
<td>24.12</td>
</tr>
<tr>
<td>BCNW 20</td>
<td>18.82</td>
<td>24.12</td>
<td>31.4</td>
</tr>
<tr>
<td>BCNW 30</td>
<td>18.36</td>
<td>25.8</td>
<td>32.44</td>
</tr>
</tbody>
</table>

The following Graphs show the Compressive strength results for M20 concrete for 7th, 14th and 28th days
VI Conclusion

1. The importance of work is to introduce the Bacillus sphaericus bacteria to understand the change in hardened properties of concrete.

2. The bacteria to be proved efficient in enhancing the properties of the concrete strength increase thus we can conclude the produced calcium carbonate has filled so percentage of void volume thereby making the texture compact and resistive to seepage.

3. The addition of bacteria with tap water is added in the concrete in proportion 10 ml/litre, 20 ml/litre. The result obtained at 7, 14, 28 days the compressive strength increased in the range of 9% to 48% when compared to normal concrete.

4. The Mix with Bacterial concentration of 30 ml/liter attained maximum increase in strength.

5. Bacterial concrete it may become yet another alternative method to replace OPC and hazardous effect on environment pollution.

ACKNOWLEDGMENT

We wish to express our immeasurable appreciation and deepest gratitude for the help and support by our project guide Prof. Rahul patil in making this study possible. We are also grateful to all our faculty and staff members of department of civil engineering and our collage for their assistance in the completion of this work.

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Utilization of waste material in civil construction
(May 2020)

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ABSTRACT There is a growing awareness in India about extensive damage being caused to the environment due to accumulation of waste materials from industrial plants, power houses, colliery pits and demolition sites and it has become of the major environmental, economic and social issues. Waste material is the material unused, unwanted and rejected as worthless into the environment in our society as whole. Waste materials coming out of industry nowadays is posing a great environmental problem in disposing them into the air, water and the land. But, with proper utilization of these materials in construction industry as well as in making road pavements will greatly help the society to have a better and pleasant environment. Substitutions of waste material will conserve dwindling resources and will avoid the environmental and ecological damages caused by quarrying and exploitation of the raw materials for making cement. These waste material can partly be used, or processed, to produce materials suitable as aggregates or fillers in concrete. Use of waste products is not only a partial solution to environmental & ecological problems and it significantly improves the micro structure and consequently the properties of concrete. The output of these waste materials in India are more than double the production of cement and other construction material used in all the civil engineering activities. So, use of waste materials not only to make the cement concrete (generally used in all the construction activities) less expensive, but to provide a blend of tailored properties of waste materials and Portland cements suitable for specified purpose. These paper outlines regarding the optimum utilization use of waste materials in some construction activities as a green concept, which ultimately reduces the environmental pollution.

INDEX TERMS waste material, construction, environment, concrete

INTRODUCTION The Waste materials that are commonly known are blast furnace slag, fly-ash, silica fume (from power plants) recycled aggregates (from demolition sites), solid waste, plastic waste (domestic waste) and rubber waste (commercial waste). Partial replacement of Portland cement with waste materials like blast furnace slag, fly ash, silica fume (from power plants), recycled aggregates (from demolitions site) solid waste, plastic waste (domestic waste) and rubber waste (commercial waste) will be a great help in reducing environmental pollution and also in reduction in manufacturing of cement and other material that required for the construction activities. One of the major challenges of our present society in the protection of environment. Any construction requires several material such as concrete, steel, brick, stone, glass, clay, mud, wood and so on. However, the cement concrete remains the main construction material used. In construction industries for its suitability and adaptability with respect to the changing environment, the concrete must be such that it can conserve resources, protect the environment, economize and lead to proper utilization of energy. To achieve this, major emphasis must be laid on the use of waste and byproducts in cement and concrete used for new construction. The utilization of recycled aggregates is particularly very promising as 75% of concrete is made of aggregates. The enormous quantities of demolished concrete are available at various construction site, which are now posing a serious problem of disposal in urban areas. This can easily be recycled as aggregate and used in concrete. As the problem of disposing these waste materials became a big environmental problem, the proper utilization of these big materials again in construction activities will be a great relief to the society. Some of the important elements in this respect are the reduction of the composition of energy and natural raw materials, systematic composition and use of waste materials to a great extent. Research and development activities have been taken up even in India for proving its feasibility, and economic viability and cost effectiveness for the use of waste materials in all the construction activities.
POINTS TO BE CONSIDERED WHILE UTILIZING WASTE MATERIAL IN CONSTRUCTION:

1. Build It Back Into the New Building
   The smartest way to recycle construction waste is to integrate it back into the new building or the new building site. Some of this may happen naturally. In remodeling projects, walls are not necessarily demolished. They may simply be redecorated, moved, or reconfigured. Lumber cut-offs in woodframed constructions may be useful for fire blocking or as spacers.

2. Build to Standard Dimensions
   Building projects may offer the chance to use building materials supplied in standard measurements. The less you have to adapt or cut, the less wastage you will incur – not to mention the time and effort saved. Framing layouts can be planned to use standard wood lengths, for instance. Standard dimensions also make it easier to reuse any materials you have left over.

3. Locate Your Local Recycling Center
   The key word here is local. If it takes too much time, effort, and gas to transport construction waste for recycling, look for another solution (like avoiding waste instead). If the recycling center is close enough, find out what they take and when they open. Then add necessary trips to your overall construction schedule and plan to minimize overall impact. Take waste to the recycling center on the way out when you go to fetch new building materials, for instance.

4. Practice Deconstruction Instead of Demolition
   Organizations exist in some areas to remove reusable items without damage for reuse in social housing projects. There may also be tax advantages to the customer who is paying for the overall project. If this is not possible, an alternative is a front yard sale of such items during the construction project. Radiators, grates, piping, appliances, and fittings in sufficiently good condition can all qualify.

5. Calculate the Savings
   In case you had any doubts about it, recycling construction waste is not only a way of helping the planet, but also an opportunity for higher profitability, better prices to customers, or both. In buying fewer new materials, recycling waste without having to transport it, or reselling it where is has market value, there are positive economic as well as environmental consequences. Good construction accounting tools will help you to manage the savings to be made through recycling.

3 TYPES OF WASTE MATERIAL CAN BE REUSED IN CONSTRUCTION:

Asphalt Paving
• Land Clearing Residuals
• Wood
• Sanitary ware

• Buildings
• Metals
• Concrete
• Brick
• Asphalt Paving:
   Due to heavy traffic loads and environmental conditions that are not considered in the design of asphalt pavements, more and more asphalt pavements are failing prematurely, as a result overlaying or replacing failing pavements become a necessity. Overlaying a pavement is a simple process, where a new asphalt layer is added, the problem with overlaying is the nature of the asphalt mix materials, which will take the form of the lower layer and most distress will be reflected on it after opening road for traffic. The best solution is to mill the surface of the old pavement to remove the affected part of the pavement, then the question is what to do with the removed materials, either dump it in landfill or reuse it as construction materials, hence the use of reclaimed asphalt pavement (RAP) came into the picture with a promise of many economic and environmental benefits. Currently, almost all RAP is recycled back into pavements, for example it is estimated that a 30,000 ton pile of RAP with an average 6% liquid asphalt binder content is the equivalent of about 28,200 tons of clean aggregate plus 10,000 Barrels of liquid asphalt, which could replace virgin materials. The most recycled materials in the is asphalt pavement materials. Over 80% of asphalt pavement materials milled from roadways is reused. It can be mixed into new pavement or used as a sub-base or fill material.

• Land Clearing Residuals:
   Mulch is any material that is spread or laid over the surface of the soil as a covering. It is used to retain moisture in the soil, suppress weeds, keep the soil cool, and make the garden bed look more attractive. Organic mulches also help improve the soil’s fertility, as they decompose. Organic mulch will decompose and have to be replaced, but in the process, it will also improve your soil’s fertility and its organic content. The dryer and woodier the mulch, the slower it will decompose and the fewer nutrients it will give to the soil. It pays to know the origin of manure, compost, and straw since these materials can contain viable weed seeds. The last thing you want is to spread a mulch that is going to start sprouting and make more work for you. Each type of organic mulch has its own use.

• Wood:
   Wood cement composites (WCC) are a new opportunity for recycling post-consumer wood and chemically treated wood fiber in the manufacture of building and sound absorbing products. The technology is employed throughout the world to produce stay-in-place insulated wall forms, structural panels, acoustical treatments, and highway sound...
barriers. However there is no evidence that WCC technology has been applied to C&D wood waste. Our study examines the use of "mulched" wood fiber prepared by harmer mills typically found in C&D recycling systems. We are demonstrating that sufficient strength and durability can be achieved to satisfy established building codes and standards.

Sanitary ware:
Ceramic wastes are classified as non-recyclable wastes in South Africa, except for the normal use as filling material. Based on research regarding recyclable Construction and Demolition (C&D) wastes, ceramic wastes have the potential to be used in concrete production. However, there are no guidelines and standards to the usage of these wastes in concrete. In addition, the local construction industry does not have knowledge and experience to utilize the material.

• Metals:
Recycled steel metal scraps can be made into higher quality tools through a process using an electric arc furnace. Stainless steel can also be made in this way. Copper scrap is made into products using some of the same processes as steel, which also include blast and reverberator furnace processes. Aluminum scrap metal can also be melted at a much lower temperature than virgin aluminum, so the process consumes much less energy. This is generally true of all recycled metals, which not only saves on energy but Co2 emissions as well. This protects our environment, as well as providing an economic savings in the manufacturing process, which is then hopefully passed on to the consumer.

• Concrete:
In the process of urban development, with the reconstruction of old city, a lot of waste concrete will be generated. At the same time, civil engineering construction, earthquakes and wars also can generate a large number of waste concrete. The existence of waste concrete will directly pollute environment and occupy the land resources. The recycling utilization of waste concrete is benefit to environmental protection and saving resources, and is also benefit to realize the sustainable development of building materials. Waste concrete research situations in and abroad were introduced. The crushing and regeneration technology of waste concrete were studied. The material properties of recycled concrete were analyzed and some advices about development of recycled concrete were presented. By screening the waste concrete to particular sizes it can be used as a replacement for aggregates.

4. BENEFITS:
• You effectively save the need to procure and consume natural raw materials • You in turn save energy, decreasing harmful emissions, and reducing space needed for landfills. • You reduce the cost of construction, extending your budget, meaning you spend it on other living requirements. • Creates employment opportunities and economic activities in recycling industries. • It becomes economical for new building works.

5. CONCLUSION:
• It has been established that materials & components from demolished buildings are being reused for new construction works as well as renovation projects, especially by low-income communities in developing countries. • As sorting and recycling facilities become more widespread and better developed it will be easier to redirect our waste from landfill. • In order to reduce the construction waste, during the time of construction order only the correct amount of raw materials.

6. REFERENCES:

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Smart Construction Material

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ABSTRACT  Asbestos cement sheets and galvanized iron sheets in corrugated forms are being extensively used for roofing in housing, industrial sheds, godowns and other structures. Asbestos cement sheets fail under impact load. The material ‘asbestos’ used for the manufacturing of sheets is a hazardous to human health. It causes diseases like asbestosis and lung cancer to the people working for the manufacturing of the sheets. Due to this reason it has been banned in many countries such as USA, Russia, France, Canada, etc. In India also asbestos sheets are banned but due to economy most of our citizens prefer it taking risk of health so, we thought of given our people a better alternative within their limits.

INDEX TERMS:

Introduction
1. PROPERTIES OF NYLON ROPES-
   1. Know your Nylon rope requirements-
      The correct size is important. Using undersized rope causes undue strain on the rope. Proper selection of the right rope size is the greatest factor in getting full use and long life from your rope. In addition to size, other factors such as type of lay and special fiber treatment will determine the selection of rope. Most industries making regular use of rope have selected certain types as best suited to perform specific jobs. In some cases, special purpose ropes have been developed to meet particular needs. Generally, the proper size and type of rope can be specified from your past experience and the recommendations of your supplier.
   2. Rope construction-
      Manufacture can make 3- Strand, 4- Strand, or 8- Strand Plaited Ropes as per requirements.
      3-Strand ropes are preferred on most applications because of its flexibility, knot ability, and easy in handling. They come in an easy to splice medium lay; however can be ordered to conform to specific lay requirements either softer or harder. 4-Strand ropes have a slightly firmer lay and provide a rounder rope with more outside surface and more traction on sheaves and objects to be turned or gripped. It is available in various core constructions depending on the rope's application. 4-Strand Manila ropes is approximately 7% heavier than 3- Strand and has a breaking strength approximately 5% less. 8-Strand plaited ropes have four left-hand laid strands and four right-hand laid strands, paired off parallel and woven together. Used mostly for marine applications, its neutral (or balanced) construction provides excellent hocking resistance. It is available in5"To15” circumference (or 1-5/8”to5” diameter). 3.
   3. Treatment-
      All Natural Fiber Ropes are lubricated with a water repellent treatment that resists moisture, mildew, and rot. The lubrication also guards against internal chaffing and wear. Upon request, ropes may be treated with Copper Quinolinolate, Copper Napthanate, Tar, Graphite impregnated, or Tallow treated. These treatments are generally for the added protection of fibers against rot and mildew.
   4. Proper use of net-
      New rope should be thoroughly inspected throughout its entire length before it is placed in service to determine that no part of it is damaged or defective. After it is placed in service, rope should be inspected at least every thirty days under ordinary circumstances; more often if it is used to support scaffolding or other supports upon which men work. If it is exposed to acids or caustics, it should be inspected daily. Inspection should include examination of the entire length of rope for wear, abrasion, broken or cut fibers, displacement of yarns or strands, discoloration or rotting. To inspect the inner fibers, the rope should beuntwisted in several places to make sure the inside yarns are bright, clear and unspotted. The specification tables show breaking strengths and safe working loads. Rope loaded to over 75% of its breaking strength will be permanently injured. Damage from this cause may be detected by examining the inside threads which will be broken to an extent governed by the amount of the overload. Such damage may also be determined by the reduced diameter of the weakened section of the rope. Care should be taken to prevent kinking a rope. Even a moderate strain may over-stress the fibers at the point of the bend, producing a serious defect and one that may be difficult to locate.
   5. Rope care and safety-
      Good rope care - better rope service or the service that should be expected from good rope and for the safety of men and materials, rope should be handled and used with care. By following these points in rope selection,
handling and storage, it will remain dependable and safe over long periods. Keep rope clean. Dragging rope on the ground or over rough, gritty surfaces allows abrasive particles to work into the rope and weaken the fibers. If rope becomes muddy or dirty, it should be washed and dried thoroughly before storing.

6. Kinks cause rope failure
Prevent kinks which cause permanent damage and weakening of the rope. If kinks should form, or if rope is continually twisted in one direction, as over a winch, remove kinks or restore balance in the rope by throwing in twist in opposite direction.

2. CONSTRUCTION PROCEDURE FOR MANUFACTURING OF NYLON CEMENT SHEET

1. Proportioning of material
Initially we decided the material to be used for casting of sheet, and accordingly we decided the proportion. The sand cement mortar ratio was decided as 1:2 and water cement ratio was also decided as 0.35. Then the size of Nylon was decided according to member size. The nylon of cut size was weighted by weighing equipment; it was 110 gm for 1.5 sq.m.

2. Preparation of formwork
For casting corrugated sheet we used Asbestos cement fully corrugated sheet as formwork from both the sides. The water was sprinkled on asbestos sheet to prevent the water absorption from the sheet. The polythene paper was laid on the asbestos sheet for easy removal of casted sheet and also for providing good finishing.

3. Mixing of material
All the material which was thoroughly weighed batched was transported by us to mixing area. Sand and cement was dry mixed thoroughly. Then the water was added slowly while mixing the mortar. Mortar mixed with help of shovel.

4. Placing of mortar
Firstly we placed Nylon net of 0.75 mm dia. on Asbestos sheet, net was placed very loosely on to the sheet so to prevent tensioning of net after plating of concrete. Then we placed the mortar on corrugated sheet with uniform thickness of 8 mm. Care was taken that the net under the mortar doesn’t come out.

5. Vibration of sheet
The sheet was kept on table vibrator the polythene paper was laid on mortar and then another sheet was laid on it. Then the vibration started and continued for 1 min. Then the sheet at top was removed and thickness was measured with the help of gauge marker and finishing was also checked. The thickness was nearly 8 mm. Again the sheet was laid and vibration was continued for 2 min. Again the sheet was removed and thickness was checked it was 8 mm and was ok.

6. Finishing of casted sheet
By using table vibrator and polythene paper the smooth finish was obtained on the surface, but the voids were seen at some part of sheet so we finished the voids with the help of trowel. The sheet was cut in size when the mortar was green with the help of trowel.

7. Curing of sheet
We carried out Curing of sheet after 24 hours of casting the sheet. Spreading gunny bags on the sheets. By these the curing was done with less water and soil remained moist for long time.

3. SOME COMMON MISTAKES TESTS CARRIED ON NYLON REINFORCED SHEETS:

The (Reference code is 5913:1970)
1. Visual inspection test
2. Water absorption test
3. Test for impermeability
4. Acid resistance test
5. Load bearing caacity test

Visual inspection test: p
The sheets casted are inspected visually to check the following
1. Uniformity of texture: - The texture on the both side of the formwork was uniform.
2. Neatness and straightness of the trimmed edges: - The trimmed edges were uniform and straight after some cutting in the fresh condition
3. Squareness of the corners: - The corners were square by cutting sheet in green condition.
4. Rectangularity: - The rectangular shape was maintained.

Water absorption test: Specimen: From each of the sheets casted in accordance with the sampling, a specimen of 175 mm x 175 mm was taken. Procedure:

The specimens were completely immersed in water at 1520°C for a period of 18 hours. These of taken out and weighed after removing surplus moisture with a damp cloth (M1). The specimen shall than be placed in an air oven capable being rest to 150°C, and then maintained at that temperature constantly. The heating was commenced with ventilator wide open, raising the temperature from about 105-150°C to the specimens to constant mass. The test pieces shall than be cooled for at least one hour in a desiccators containing anhydrous calcium chloride and weigh (M2).

Results: - The absorption was calculated as follows:

\[
\text{Absorption \%} = \frac{M1 - M2}{M2} \times 100
\]

Where, \( M1 \) = mass in grams of specimen after absorption. \( M2 \) = mass in grams of specimen heating.
Test for impermeability: Specimen: A piece of nylon sheet 100mmx100mm was cut. Procedure: A transparent metallic tube 35+5mm diameter & 300mm long was sealed to the test piece and held vertically. The test piece was supported on a suitable arrangement, which provides the bottom surface to be inspected. The sealing of the tube was done for corrugated sheet at the center of the valley and for semi-corrugated sheets in the flat portion between corrugations. The tubes may be suitable shaped at the bottom for these purpose, as necessary. The tube was filled up with water carefully to about 250mm height, if necessary by providing overflow liner to maintained the required constant height, and it was ensured that water does not leak through the sealing. Arrangement was provided in the test equipment to evacuate entrapped air. The test was conducted at 15 to 35 degree centigrade and at a relative humidity of 45 to 75 percent.

Acid resistance test: Specimen: Take a piece of 65mm x 65mm measured along the center of the curved section. Procedure: Each specimen was placed upright for 24 hours in 270ml of 5% acetic acid solution at 15 to 35 degree centigrade contained in a vessel of such a size that the specimen is entirely immersed. Separate vessels and solutions were used for each specimen. The concentration of the acetic acid was determined before & after immersion of the specimen by titration against a solution of sodium hydroxide of known concentration (app. 0.5N), using thymol blue as indicator. For titration, 10ml of the acid solution (0.040g in 100ml 95% alcohol) added to it. The end-point to be taken is that of the color change from yellow to blue corresponding to pH value 8.0 to 9.5; the small amount of gelatinous precipitate formed does not interfere.

Result: The result was reported in terms of grams of acetic acid per square meter of area of the specimen & this value was calculated from the fall in concentration, assuming that 1ml of 0.5N sodium hydroxide solution hydroxide solution is equivalent to 0.030g of acetic acid as follows:

\[
\text{Mass in g of acetic acid used per m}^2 = \frac{0.030 \times 370}{10A} (x-y) \\
= 1.11(x-y)
\]

Where,
X = volume in ml of 0.5N sodium hydroxide use at the initial titration, 
Y = volume in ml of 0.5N sodium hydroxide used at the final titration, and 
A = area in m2 of unprotected nylon cement sheet.

Load bearing capacity test: Specimen: The specimen for the test shall consist of full sheets or 1.25m long cut from full sheet and was selected in accordance with the method of sampling given in the relevant specification. Procedure: Immediately prior to test, the specimen was completely immersed in water at 15 to 35 degree centigrade for a period of 24 hours. Each specimen was freely and evenly supported with its smooth side up on parallel rigid hardwood, cast iron or steel bearers 50mm wide and of a length at least as great as the width of the specimen, and set at right angles to the corrugations. The bearers were placed 1m from center to center. The load was applied at a rate not greater than 2000N/min.

4. ADVANTAGES OF N.R.C. SHEETS
1. Nylon cement sheet is economical than other roofing
2. Substitutes.
3. It is non hazardous for human health as well as for environment.
4. Material available in local market can be used for manufacturing of sheet.
5. Skilled labours are not required for manufacture of sheet. 6. it gives better strength.
7. No heavy machinery is required for castingsheet.
8. When it obsolete it can be recycled.
9. It creates employment opportunity.

CONCLUSION- The use of nylon nets in combination with cement mortar is a feasible concept. It was an attempt to replace the conventional asbestos cement sheets. Nylon Cement Sheets can be locally manufactured on sites and can used for low cost housing, small cattle shades, industrial shades, godowns, storage houses etc. where Load Bearing Capacity of roofing isn’t the significant factor. The cost of Nylon Sheet is Rs.146/- for 1m2 and that of the A.C. Sheet is Rs.175/- for 1m2 in market.
Nylon Cement Sheet can replace A.C. Sheets where loading isn’t the prime factor over economy. 2) Nylon Cement Sheets can be locally manufactured on sites and can use for low cost housing, small cattle shades, industrial shades, godowns, storage houses etc. 3) Recommended spacing of the purlins for placing the sheets is up to 1.4m.

5. REFERENCES


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