DEVELOPING ALTERNATIVES FOR THE VIRGIN ABIOTIC MATERIALS

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FLOW OF PRESENTATION

Introduction

Substitute materials in cement/concrete

Research activities at University of Bath UK & Goa

Conclusions

INTRODUCTION

After water, concrete is the most widely used material in the world : Twice more than plastic, steel, aluminum, and wood, taken together.

Production of cement and concrete, both require consumption of natural resources/raw materials like top fertile soil, sand, aggregates.

Environmentalists have raised an alarm on indiscriminate mining of natural sand from rivers since it may create imbalance in the ecosystem.

INTRODUCTION

CO_2 from cement manufacturing : Globally = 5% (U.S. < 1.5%) : (2008823 kilo tonnes of CO_2 was emitted in the year of 2010 in India)

In manufacture of cement, combustion requires 35 – 40% of energy & calcining requires 60 - 65% of energy

Production of cement (calcination of limestone and clay at very high temperature using natural fuel), releases about 1 tonne of CO_2 for every tonne of cement produced

VARIOUS SUBSITUTES IN CEMENT & CONCRETE

Substitute in Cement production:

1. Flyash
2. Ground Granulated blast Furnace Slag (GGBS)
3. Metakaolin

Substitutes in Concrete: (for cement/coarse/fine aggregares)

1. Flyash
2. GGBS
3. Metakaolin
4. Plastic waste
5. Rubber waste
6. Glass waste
7. Agricultural waste
8. Construction and demolition waste

RESEARCH ACTIVITIES AT UNIVERSITY OF BATH UK & GOA

In 2014, Government Polytechnic, Bicholim was awarded a United Kingdom India Education Research Initiative (UKIERI) project of "Development of structural concrete with help of plastic waste as partial replacement for natural sand"

Project duration : 02 years

Funding: Rs. 50 lakhs (shared)

Principal Investigators: Dr. Purnanand Savoikar (Goa)

Dr. John Orr (University of Bath, UK)

Technology Partners : M/s. Aakaash Mfg. Co. Ltd.

RESEARCH WOK AT GOA & BATH

Polyethene bag waste

- Ordinary Portland cement with GGBS as partial replacement up to 50%
- Coarse aggregates of size 10mm and 20mm
- Natural sand both coarse and fine
- Standard glenium/naptha based admixture (1% by weight is used).
- Plastic waste replacement up to 40% is tried.

- Marginal decrease in compressive strength over target mean strength
- Need to undertake long term durability studies

RESEARCH WOK AT GOA & BATH

Highlights:

- **Eleven concrete mixes tested with plastic as partial replacement for sand.**
- **Target compressive strength of 54 MPa to replicate structural concrete.**
- **Control of particle size distribution minimises change in compressive strength.**
- **PET fragments graded as sand can be used at a replacement ratio of 10%.**
- **Save 820 Mt sand per year by replacement with waste plastic**

Elsevier Journal - Construction and Building Materials (2018) : Performance of structural concrete with recycled plastic waste as a partial replacement for sand - J. Thorneycroft, J. Orr,P. Savoikar, R.J. Ball

MATERIALS TESTED

Plastic types.

Plastic material	Description
PET	Recycled polyethylene terephthalate (PET) bottles, washed and shredded. The plastic is ungraded, with particles ranging from 0.05 to 15 mm in diameter. Fourier transform infrared spectroscopy (FTIR) was used to confirm the type of plastic by sampling a random selection of particles
HDPP	Virgin 3 mm diameter smooth finished spherical high density polypropylene (HDPP) pellets
HDPE	Recycled, high-density polyethylene (HDPE) carrier bags shredded into thin plates of between 5 and 500 mm^2. The material was washed with tap water prior to casting.
PPF	Virgin polypropylene multifilament fibres, 20 mm length, diameter 0.05 mm
PPS	Virgin polypropylene strips, 20 mm long, 3 mm wide, triangular in cross section

RESULTS OF THE STUDY

- **substituting plastic into a concrete mix causes a decrease in compressive and tensile strength due to the poor bond between the plastic and surrounding matrix.**

- **use of a graded PET plastic matched to the size of the sand particles it replaces, and at a replacement of 10% by volume, gave the most promising overall performance.**

- **this material is furthermore cost effective to produce and comes widely available as a waste material in many markets.**

CURRENT RESEARCH AT GOA ENGINEERING COLLEGE

(1) One UG group has worked on replacement of natural sand with power plant waste which used agricultural waste as fuel in medicine factory in Goa

Cashew kernel - Risk husk - Saw dust - Wood chippings

CURRENT RESEARCH AT GOA ENGINEERING COLLEGE

Results of lab tests for M30 Grade concrete Target mean strength 38Mpa

SAMPLE	% OF NATURAL SAND	% OF WASTE ASH	7 DAY STRENGTH	28 DAY STRENGTH
1	100	0	27.21 Mpa	46.30 MPa
2	40	60	24.48 MPa	41.33 MPa
3	0	100	22.77 MPa	33.71 MPa

CURRENT RESEARCH AT GOA ENGINEERING COLLEGE

(2) One UG group is working on partial replacement of natural sand with power plant waste (Briquette Ash) from brewery in Goa

CURRENT RESEARCH AT GOA ENGINEERING COLLEGE

Initial Results:

For M25 grade concrete (3 Days strength) :

100 % natural sand is used – 26.69 Mpa
20 % replacement – 22.85 MPa
40 % replacement – 17.19 MPa

(3) Three Ph. D. students are working under my supervision in the area of advanced testing for durability/corrosion/ carbonation for

(i) alternative materials used for cement
(ii) alternatives materials used for sand & coarse aggregates
(iii) replacement of natural sand with marine sand

CONCLUDING REMARKS

- **Over-utilisation of top fertile soil for cement**
- **Over-utilisation of natural sand for concrete**
- **Over-utilisation of metal aggregates in concrete as coarse aggregates and well as manufactured sand**
- **Need to develop sustainable solutions - alternative materials using waste materials/Bye-products**
- **Concerns : long term durability/ regular availability & state of waste material/ general acceptance**
- **Resolve environmental problems /issues**
- **Achieve resource efficiency/circular economy**
- **Collective efforts from research institutions at local/ national level/Govt bodies/Funding agencies**

THANK YOU VERY MUCH.....