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EFFECT OF PAPER WASTE ON CONCRETE PROPERTIES: SUSTAINABILITY APPROACH

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ABSTRACT

In Construction field is widely developed from day to day. The development is causing the increasing needs of raw materials such as gravel. This high demand is causing the materials becoming extinct. Apart from that, this world also had facing the high amount of waste products which including waste paper. Research has proven that the waste paper can be used as recycled paper in construction field. The construction industry consumes a large amount of non-renewable resources. On the other hand, more waste paper ends up in landfill or dump sites than those recycled. Consequently, recycling waste paper for use as a construction material constitutes a step towards sustainable development. Papercrete is a kind of fibrous cement, made by shredding paper (old newspapers, magazines paper, cardboard etc.) into pulp in water and additional ordinary Portland cement to it and in some case sandy soil to be used as an additive. Papercrete is a sustainable building material due to reduced amount of cement usage and recycled paper being put to good use. This research effort aims at determining the workability of fresh papercrete produced using waste office paper in order to ascertain their suitability for use as a building construction material. For each of the mix proportions considered, replacement of volume of aggregate by paper pulp is carried out ranging from 10% to 20% with constant interval of 2.5%. Papercrete was recommended to be an effective and sustainable material for the production of lightweight and fire-resistant hollow or solid blocks to be used to make partition walls of especially high-rise buildings.

KEYWORDS: Papercrete, Green-Construction, Low-Cost Housing, Recycling, Sustainability, Waste Paper.

INTRODUCTION

Most waste paper ends up in landfill sites while some are incinerated. Thus, they pollute the air, water and land. Waste paper recycling has not been able to match waste paper generation. One unique recycle opportunity is using waste paper as a construction material. The construction industry has been identified as one of the largest consumer of non-renewable resources. Consequently, using waste paper for construction not only has the potential of waste paper recycling keeping pace with its generation but it will also reduce the demand pressure on global natural resource.

Current Scenario of Construction Industry Worldwide

Since the large demand has been placed on building material industry especially in the last decade owing to the increasing population which causes a chronic shortage of building materials, the civil engineers have been challenged to convert the industrial wastes to useful building and construction materials. This experimental study which investigates the potential use of waste paper for producing a low-cost and light weight composite as a building material. These alternatives were made with papercrete. More than 450 million tons of paper is produced worldwide per annum and it is expected that the demand for paper will reach 500 million tons per annum by the end of 2020. The environmental impact of pollution caused by discarding paper and paper products is also quite significant. In recent years, paper and paperboard constituted the largest portion of the United States (US) municipal solid waste generation (U.S. EPA 2010; 2011; 2013; 2014). In 2006, for example, paper and paperboard accounted for 33.9% (85.29 million tons) of the US municipal solid waste generated. Of this waste generated, 12.36 million tons of newspaper and 6.32 million tons of office-type paper were generated (U.S. EPA 2007)

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Use of Paper Waste: Papercrete

Papercrete is a tricky term as the name seems to imply a mix of paper and concrete, known as papercrete. But to be more accurate, only the Portland cement part of concrete is used in the mix. Arguably, it could have been called "Paperment" Papercrete may be mixed in many ways and different types of papercrete contain 50%-80% of waste paper. Papercrete is a recently explored construction material that consists of re-pulped paper fiber with cement or clay. It is an experimental material that replaces a certain proportion of cement with paper in the normal concrete mix. It is perceived as an environment friendly material due to the vital recycled content. By doing so, the total weight, cost and the carbon emissions during production are reduced. Its use remains limited, because of the lack of official data about its structural properties, mechanical properties and durability. In order to establish papercrete as a standard material, further experimentation is needed.

When paper is mixed with cement, it creates a very good bond and the final product is both lightweight and strong. Fibers contribute to sound insulation properties and help in crack control. Portland cement is an integral component of the mix and acts as a binder. Cement reduces the drying time and the effect of pulp shrinkage and increases the strength and dimensional stability. However, it adds weight to the mix and makes it more brittle. Adding coir, sand, dirt or pumice increases the volume and the mineral content. Sand adds thermal mass and makes the mix stronger and impervious to water but results in heavier structure.

Papercrete is a material originally developed 80 years ago but it is only recently rediscovered. Papercrete is a fibrous cementitious compound comprising waste paper and Portland cement. These two components are blended with water to create a paper cement pulp, which can then be poured into a mould, allowed to dry and be utilized as a durable building material. It should be noted that papercrete is a relatively new concept with limited scope.

Objective of using of Paper Waste

a) To utilize the waste materials like paper, fly ash, in the process of manufacturing new type of eco-friendly bricks, namely papercrete bricks.
b) To manufacture and study the strength and durability of the papercrete bricks in order to effectively use these papercrete bricks commercially for construction purposes.
c) To extend the investigation further to study the structural behavior of the papercrete brick masonry experimentally and theoretically.
d) The objective of this study is to determine the compressive strength of a lightweight concrete with wastepaper as aggregate replacement.
e) To recommended being an effective and sustainable material for the production of lightweight and fire-resistant hollow or solid blocks to be used to make partition walls of especially high-rise buildings.
f) As builders and building owners are pressurized to use sustainable construction materials, previously tassel building material known as papercrete as gained a lot of popularity amidst the recent greening up efforts.

LITERATURE REVIEW

Claire et al (2010) manufactured papercrete building elements for pre-fabricated houses. They stated that papercrete is made from low-grade waste paper which would otherwise go to the landfill. Though its carbon foot print is very low it provides excellent thermal insulation. As a matter of fact, it is suitable for use in high performance, low cost housing.

Jesus et al (2008) investigated the reuse of sludge in the paper and board industry and suggested that the reuse of the sludge could do away with the 25 problem of disposal and this is a cost-effective management alternative. They concluded that the approximate economic analysis is better than the reuse of sludge in the pulp and paper industry could be feasible.

Fuller et al (2006). They claimed that these "Papercrete" structures are strong and good at durable and insulating. They also reported the sound absorption and creep characteristics. At last, they concluded that, it stands to reason, papercrete could have wide–ranging implications for residential construction and for the natural environment. The challenge facing engineers now is the lack of information about papercrete and meaningful research is needed in order to learn more about the material and its properties. Only then, the full potential of this recycled material can be realized.

Gallardo et al (2006) focused their investigation on the viability of using paper mill sludge as an alternative material. This can be applied as a partial replacement of fine aggregates in manufacturing fresh concrete intended to be used for low cost housing project. Based on the results of this study, they concluded that the most suitable mix proportion is 5% to 10% replacement of paper sludge to fine aggregates. Any further percentage replacement higher than 10% would result in a decrease in both compression and tensile strength.

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METHODOLOGY

Concrete for M20 & M25 Grade was designed. The replacement of aggregates was done by paper plub with percentage varying from 0, 2.5, 5.0, 7.5, 10.0. 12.5 % by volume. The Fresh and hardened properties of papercrete was studied.

Testing: 1) For Fresh concrete: Workability
2) For Hardened concrete: Compressive Strength at 3D, 7D & 28D

Material used:
Cement used: OPC 53 Grade
Flyash : Dirk India P60
Alccofine : Alccofine 1203
Paper properties: Table no 4
Mix proportion: M20 (Table no 5), M25 (Table no 6)

Table no 4 Physical Properties of Office Paper

PHYSICAL PROPERTIES OF OFFICE /BUSSINESS PAPER	VALUES
Thickness value	105-110µM
Typical moisture value	4-4.5%
Smoothness value	100-300mls/min
Bursting strength value	250-300kPa
Tear resistance value	500-600mN
Static coefficient of friction	0.50-0.65
Kinematic coefficient of friction	0.35-0.50

Mix proportion

Mix design of concrete is done as per IS 10262:2009 for M20 & M25 Grade of concrete.

Table 5: Mix Proportion (%) for M20 Grade of concrete

	CM	PC1	PC2	PC3	PC4	PC5
OPC	70	70	70	70	70	70
Flyash	25	25	25	25	25	25
Alccofine 1203	5	5	5	5	5	5
Fine Aggregate	52	46.8	45.5	44.2	42.9	41.6
CAI	24	21.6	21	20.4	19.8	19.2
CAII	24	21.6	21	20.4	19.8	19.2
Paper pulb	0	10	12.5	15	17.5	20
water	100	100	100	100	100	100
admixture	1.2	1.2	1.2	1.2	1.2	1.2

Table 6: Mix Proportion for M25 Grade of concrete

	CM	PC1	PC2	PC3	PC4	PC5
OPC	70	70	70	70	70	70
Flyash	25	25	25	25	25	25
Alccofine 1203	5	5	5	5	5	5
Fine Aggregate	50	45	43.75	42.5	41.25	40
CAI	24	21.6	21	20.4	19.8	19.2
CAII	26	23.4	22.75	22.1	21.45	20.8
Paper pulb	0	10	12.5	15	17.5	20
water	100	100	100	100	100	100
Admixture	1.2	1.2	1.2	1.2	1.2	1.2

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RESULTS

Testing results for all mixes are presented in graphical way from figure 1 to figure 3 for the following test:

1) Workability Test (Slump in mm at 30min)
2) Compressive Strength (3D, 7D & 28D)

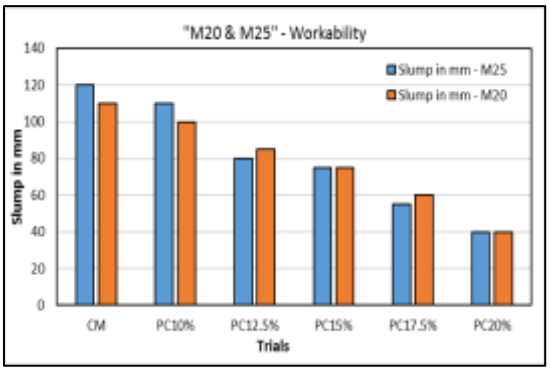

Figure 4: Slump results for M20 & M25

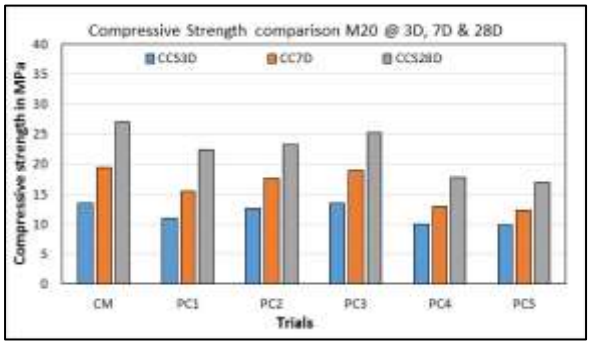

Figure 5 : Compressive Strength results for M20

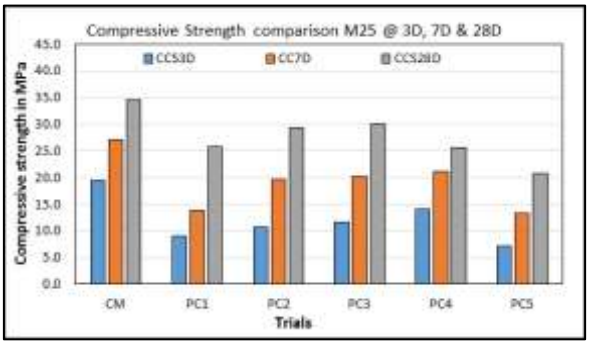

Figure 5 : Compressive Strength results for M25

CONCLUSION

1) Workability for both M 20 & M25 grade of concrete decreases with increase in % replacement of paper pulp.
2) For both the mixes i.e M20 & M25 grade of concrete, it is observed that 10% to 15% replacement can considered as acceptable percentage limit for repacement as the strength observed is well acceptable range.
3) The low bulk density of papercrete indicates that they are lightweight and can be used in the form of either hollow or solid blocks for making walls of buildings, especially, high-rise buildings. This property also makes papercrete good for building arches and domes
4) Papercrete has a high fire resistance. This is evident in the residual compressive strength of papercrete obtained after been subjected to heat of high temperature.
5) Papercrete should not be used for external walls and near-ground walls because of its high water absorption capacity. If it has to be used for external walls, the surface of the walls must be waterproof. It should not be used within 1 m above ground surface. Also, a damp-proof membrane should be placed before its use to prevent the absorption of water due to capillary rise.
6) Papercrete can use for inner wall construction in place of bricks which has high density; thereby they increase the dead weight of the structure which is reduced by using papercrete.
7) No government approval but it can be used for construction.
8) Good choice to utilized waste paper as it is economical.
9) Papercrete made with newspaper have better structural properties than those made with office paper but it also has a higher water absorption capacity.

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REFERENCES

[1] Bhooma Nepal and Vanita Aggarwal (2014) "Papercrete: A Study on Green Structural Material" International Journal of Applied Engineering Research. ISSN 0973-4562, Volume 9, Number 3 (2014) pp. 253-260
[2] Isaac I. Akinwumi, Olasunkanmi M. Olatunbosun, Oluwarotimi M. Olofinnade, Paul O. Awoyera (2014) "Structural Evaluation of Lightweight Concrete Produced Using Waste Newspaper and Office Paper" Civil and Environmental Research ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online) Vol.6, No.7
[3] Sajad Ahmad, M. Iqbal Malik, Muzaffar Bashir Wani, Rafiq Ahmad (2013) "Study of Concrete Involving Use of Waste Paper Sludge Ash as Partial Replacement of Cement" IOSR Journal of Engineering (IOSRJEN) e-ISSN: 2250-3021, p-ISSN: 2278-8719 Vol. 3, Issue 11 PP 06-15
[4] Tarun R Naik et al (January 2004) "Concrete Containing Pulp and Paper Mill Residuals", Proceedings of International Conference on Fibre Composites, High Performance Concretes and Smart Materials, Chennai, pp 515-525
[5] Solberg, G. (1999), "Papercrete and paper adobe: A revolutionary new way to build your own home for next to nothing", Remedial planet communications
[6] Ali, A., Hashmi, H.N. & Baig, N. (2013), "Treatment of the paper mill effluent – A review", Annals of Faculty Engineering Hunedoara - International Journal of Engineering 11(3), 337-340.
[7] Annesley, J. (2014), "Papercrete / paper-adobe: Insulation and thermal mass", Available online:
[8] http://annesley.wordpress.com/papercrete-paper-adobe-insulation-thermal-mass/ (accessed on 12th May 2014).
[9] Fuller, B.J., Fafitis, A. & Santamaria, J.L. (2006), "The paper alternative", Civil Engineering 76, 72-77.
[10] Nepal, B. & Aggarwal, V. (2014), "Papercrete: A study on green structural material", International Journal of Applied Engineering Research, 9, 253-260.
[11] Santamaria, J., Fuller, B. & Fafitis, A. (2007), "Structural properties of a new material made of waste paper", Computational Methods and Experimental Measurements XIII, WIT Transactions on Modelling and Simulation 46, 557-567.