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EFFECTS OF WASTE PAPER PULP ASH AND FLY ASH BY PARTIAL REPLACEMENT OF CEMENT

**** S. Swetha Chowdary **M. Malikarjuna ***J. Vara Prasad***

[*] *Post Graduate student, School of Civil Engineering Department, Nandyal (DT), A.P*
[**] *Assistant Professor, School of Civil Engineering Department, Nandyal (DT), A.P*
[***] *Associate Professor, School of Civil Engineering Department, Nandyal (DT), A.P*

ABSTRACT

An investigation was conducted to study the viability of using waste paper pulp ash as an alternative material applied as a partial replacement of cement in the manufacturing of concrete and its effect on the properties of concrete, and also, the cost and environmental advantage of using waste paper were examined. Four concrete mixes with 0%, 5%, 10%, 15% and 20% waste paper pulp ash replacement of OPC for 30MPa concrete were prepared. Based on the results obtained from the research, the highest compressive strength obtained at all test ages, i.e., 7, 14, 28, 56 and 90 days. Replacement of waste paper pulp ash for OPC, all percentage replacements showed reduction in compressive strength than the control mix. The water absorption of concrete was increased with increasing the percentage of waste paper pulp ash than control concrete.

Keywords: *Waste Paper Pulp Ash, Cement, Compressive strength Test, Split Tensile Test, Flexural Strength Test*

1. INTRODUCTION

Concrete is made up of additives of sachets, aggregation of stones, which we referred to as aggregate, embedded in cement mortar that is cement-sand mortar, in this hardened type concrete is aggregation of stones or comparable hard material embedded in what we name cement-sand mortar. The aggregates in ordinary concrete forms this skeleton matrix, it's far approximately 60 to 65% by quantity and rest all 25% is a paste, now paste approach cement and water, that mixes to paste. So, this combination is the massive aggregation of stones, sand and many others. Put together 1 to 2% words are commonly there in regular concrete. It is required that the aggregate shall be inert and strong, inert means should not be reacting with anything and it should be strong. So, that it can carry the loads.

Concrete is the most usable abundant material on the earth for infrastructure development. The concrete is used in construction industry for buildings, roadways, dams, bridges and developing of infrastructure in a country. It is the second largest consuming material in the world. Concrete is a combination of materials like aggregate, cement with addition of water. It gets strength by adding the aggregate and some admixtures such as mineral admixtures of fly ash, GGBS, Metakaolin and RHA. Cement is the binding material in concrete to get the bond between aggregates. The cement plays an important role in the concrete for development of concrete. The aggregate which are coarse and fine are the skeleton to the concrete for good strength. The aggregate used for making concrete are most commonly available materials near to the construction place.

Admixtures in Concrete

Pozzolanic material that is defined as material which in itself possesses very little cementitious value, chemically react with Calcium Hydroxide (lime) in presence of water at normal temperature and form soluble compound includes cementitious property similar to cement. Concrete is generally normal concrete or very conventional concrete is made up of cement plus water, this two makes paste, plus sand which we called as fine aggregate, it could be sand or crushed stone powder, plus stones which called as coarse aggregate. But a modern concrete is not only these four components, it has definitely two more components. Modern engineered concrete has extra substances apart from the four additives. The other materials are chemical and mineral admixtures. Mineral admixtures is the other kind of material which goes into the concrete, sometimes even in cement making are fly ash, silica fume, rice husk ash and other pozzolans or similar other material. So, a modern engineered concrete is actually six component materials to attain the sustainable concrete.

The uses of admixtures in the concrete are:

- To decrease the quantity of ordinary Portland cement.
- To reduce the pollutants that are releasing into the environment.

- To produce sustainable concrete.
- To develop concrete with low price.
- To increase the mechanical and durability properties of the concrete

Objectives of the Study

- To study the use of Waste Paper Pulp Ash and Fly Ash in the production of normal strength concrete.
- To study the different strength properties of Waste Paper Pulp Ash and Fly Ash concretes as partial replacements to OPC.
- To determine the various mechanical properties of Compressive strength, split tensile strength and Flexural Strength of concrete with Waste Paper Pulp Ash and Fly Ash as compared to regular OPC concrete.

2. LITERATURE REVIEW

This chapter represents the review about the past studies which are done on materials of Waste Paper Pulp Ash and Fly Ash. In the literature the use of Waste Paper Pulp Ash and Fly Ash are explained, the effect of admixtures in the fresh concrete and the harden concrete are explained by the authors who are studied previously.

Kostyantyn Pivnenko et al[1].: In this literature we have seen that paper product manufacturing involves a variety of chemicals used either directly in paper and pulp production or in the conversion processes (i.e., printing, gluing) that follow. Due to economic and environmental initiatives, paper recycling rates continue to rise. In Europe, recycling has increased by nearly20% within the last decade or so, reaching a level of almost 72% in 2012 With increasing recycling rates, lower quality paper fractions may be included. This may potentially lead to accumulation or un-intended spreading of chemical substances contained in paper, e.g., by introducing chemicals contained in wastepaper into the recycling loop. This study provides an overview of chemicals potentially present in paper and applies a sequential hazard screening procedure based on the intrinsic hazard, physical–chemical and biodegradability characteristics of the substances. Based on the results, 51 substances were identified as potentially critical (selected mineral oils, phthalates, phenols, parables, as well as other groups of chemicals) in relation to paper recycling. It is recommended that these substances receive more attention in waste paper.

Ilpo Ervasti et al.[2]: This journal paper shows there is no reliable method in use that unequivocally describes paper industry material flows and makes it possible to compare geographical regions with each other. A functioning paper industry Material Flow Account (MFA) that uses uniform terminology and standard definitions for terms and structures is necessary. Many of the presently used general level MFAs, which are called frameworks in this article, stress the importance of input and output flows but do not provide a uniform picture of material recycling. Paper industry is an example of a field in which recycling plays a key role. Additionally, terms related to paper industry recycling, such as collection rate, recycling rate, and utilization rate, are not defined uniformly across regions and time. Thus, reliably comparing material recycling activity between geographical regions or calculating any regional summaries is difficult or even impossible. The objective of this study is to give a partial solution to the problem of not having a reliable method in use that unequivocally describes paper industry material flows. This is done by introducing a new material flow framework for paper industry in which the flow and stage structure supports the use of uniform definitions for terms related to paper recycling. This new framework is termed the Detailed Wheel of fibre.

The Waste Framework Directive (2008) views recovered paper as a valuable raw material that needs to be recycled. This directive makes a clear distinction between recycling and recovery. According to the directive, the term recovery includes, in addition to material recycling, energy recovery as well. In the waste hierarchy, however, material recycling is favoured over recovery. Furthermore, energy recovery (incineration) is favoured over disposal (landfilling). This hierarchy is supported by life cycle assessments (LCAs) carried out.

Schmidt et al. (2007) and Villanueva and Wenzel (2007).[3]: These studies point out that from a global warming perspective as well, increasing the amount of recycling is preferable to increasing incineration. In the Waste Framework Directive, composting is also considered to be material recycling. As with incineration, when paper is composted, it disappears from the paper recycling \ chain. The composting option should be an option only when paper material is not suitable for recycling, for example when the paper material has been soiled with food.

(Monte et al., 2009)[4]: According to the Waste Framework Directive (2008), separate collections for materials like paper, metal, plastic, wood and glass need to be arranged by the end of 2015 and a recycling rate of 50% needs to be achieved by 2020 for municipal waste (Waste Framework Directive,2008). In a new proposal for harmonizing all European legislation pertaining to waste issues, an even more ambitious recycling target of 70% for municipal waste is being considered by 2030 (EC, 2014).

Cherian VarkeY et al[5]: Introduced waste paper sludge as pulp and paper mill residual solids mainly composed of cellulose fibers, moisture and paper making fillers like kaolinite clay and calcium carbonate. The author tested the cubes of size 150 x 150 x 150 mm, cylinder of 150 x 300 mm and beams of 100 x 100 x 500 mm to determine compressive strength, split tensile strength and flexural strength. The results showed that 5% replacement of cement by waste paper sludge gave higher results for all the three properties. He also added that the waste paper sludge seems to have more pronounced effect on the flexural strength than split tensile strength.

Abdullah Shahbaz Khan et al.[6]introduced paper waste as hypo sludge as it contains low calcium and maximum amount of silica. The laboratory experiment was carried out with M20 and M30 grade concrete with w/c ratio of 0.55 and 0.45 respectively as control specimen. Concrete cubes are tested for the mechanical properties varying the percentage of sludge replacing cement from 0 to 50% and found that 10 % replacement gave higher strength in all the mechanical properties. From results we came to know that the split tensile strength is comparatively higher than the compressive and flexural strength. It was concluded that increasing the percentage of paper sludge, the percentage decrease in strength in split tensile strength is much more.

Anil Kumar and Devika Rani.[7] Tested cubes and cylinders of M25 grade to determine compressive strength and split tensile strength by replacing cement by paper sludge by 5%, 10% and 15% and fine aggregate by foundry sand by 20%, 40% and 60%. The sample were cured for 7, 14 and 28 days. The results showed that 40% replacement of foundry sand increases tensile strength up to 12% and compressive strength to 0.08% whereas paper sludge increase split tensile strength for 5% replacement gave higher strength.

Sumit A Balwaik and S. P. Raut [8] Replaced the cement by waste paper sludge accordingly in the range of 5% to 20% by weight for M-20 and M-30 mix. The concrete specimens were tested for compression strength test, splitting tensile test and flexural test. These tests were carried out to evaluate the mechanical properties for 14 and 28 days. From the results we came to know that, the compressive, splitting tensile and flexural strength increased up to 10% addition of waste paper pulp and further addition in waste paper pulp reduces the strengths gradually. For M20 and M30 grade of concrete compressive strength was increased by 8% and 13%.

Prof. Jayeshkumar Pitroda and Abhinandan Singh Gill[9]: Partially replaced cement by waste paper sludge in the range of 0%, 10%, 20%, 30% & 40% by weight for M-25 and M-40 design mix. Tests were carried out to evaluate the mechanical properties such as compressive strength up to 28 days and split tensile strength up to 56 days. As per the results there is 33% decrease in the compressive strength and 5.23% reduction of split tensile strength at 10% replacement of cement by waste paper sludge for M-25 mix and there is 50.28% decrease in the compressive strength and 9.34% reduction in the split tensile strength at 10% replacement of cement by waste paper sludge for M-40 mix.

Faisal Shabbir et al.[10] Partly replaced cement by waste paper sludge ash in the ratios of 5%, 10%, 15% & 20%. The specimens were tested for initial setting time, final setting time, mechanical strength such as compressive and tensile strength and dry density. The results were compared with the ordinary concrete without the replacement of cement by waste paper sludge ash. By increasing the percentage of waste paper sludge ash, the initial and final setting time of cement gradually decreased and this leads to lighter concrete. It was observed that at 15% replacement of cement by waste paper sludge ash showed maximum increase in the compressive and split tensile strength at 28 days.

3. MATERIALS

General

In this chapter the materials used in the concrete and the experimental methods which are involved in the selection of materials are discussed. The materials used in the present study are:

- Cement
- Aggregates (fine aggregate and coarse aggregate)
- Waste Paper Pulp Ash
- Fly Ash
- Water

Cement

Cement is used as a binding material in concrete. The Cement used in the present study is manufactured by Zuari Cement Company of 53 grade OPC (Ordinary Portland Cement) confirming to IS 12269-1987 is used in this study.

Aggregate

Aggregates represent a skeleton of concrete. More or less three-quarters of the amount of conventional concrete are occupied by aggregate. It’s inevitable that a constituent occupying one of these large percentages of the mass have to make a contribution of essential properties to both the fresh and hardened product.

The concrete volume is increased by adding aggregates. Aggregate is usually viewed as an inert dispersion within the cement paste. Aggregate is classified into two types depending on the size of the aggregate.

1. Fine aggregate
2. Coarse aggregate

Fine aggregate

Aggregates passing through 4.75 mm sieve and predominately retained on 75μ sieve are classified as fine aggregate. River sand is the most commonly used fine aggregate. In addition, crushed rock fines can be used as fine aggregate. However, the finish of concrete with crushed rock fines is not as good as that with river sand. In the present study we are using River sand for the good finishing and to fill the voids between the coarse aggregate. River sand is taken from Kundhu River near Nandyal.

Coarse aggregate

Aggregates predominately retained on 4.75mm sieve are categorized as coarse aggregate. Usually, the size of coarse aggregate is from 5 to 150 mm. For regular concrete used for structural individuals including beams and columns, the maximum size of coarse aggregate is set to 25mm. For mass concrete used for dams or deep foundations, the maximum size may be as large as 150 mm. In this study the size of the aggregate is 20 mm and it is taken from the quarry nearby surrounding area.

Waste Paper Pulp Ash

Waste Paper

Waste Paper Collection: In the research, waste paper is the main constituent material type of waste papers used was only white office papers used for writing and printing purposes, and the sources were offices and business areas.

Pulp Preparation: To obtain the waste paper pulp, the waste paper processes in sequence steps were shredded manually into small pieces and then soaked in tap water at room temperature for 3 days. ,e soaked papers were mixed by hand mixing and using an onion chopper machine until slurry was obtained, and then, the slurry was dewatered until excess water was drained. A waste paper pulp in wet state is obtained after these processes. wet pulps were dried in an oven at 105°C for 24 hrs.

Waste Paper Pulp Ash Formation: A process of thermal activation provides waste paper mill sludge ash with pozzolanic properties in the range of temperatures between 500°C and 1000°C, with retention times in the furnace between 2- and 5-hours paper mill sludge calcined at 500°C for 2 hours is composed of talc, kaolinite, elite, dolomite, calcite, and quartz in this research, the waste paper pulp was calcined in a furnace at 500°C for 2 hrs by cleaning carefully the empty crucibles. After calcination, it is cooled slightly and then placed in a metal plate. When cooled to room temperature, the ashing is weighed on the balance and the calcination temperature was checked by preparation of a pertest for compressive strength of concrete containing 5% waste paper.

Fly Ash:

Fly ash is used as a cementitious material drawn from burning of coal in high temperature. There are two types of Fly ash such as

- ASTM class F
- ASTM class C

Fly ash used in this study was low-calcium (ASTM Class F) dry fly ash. Since the ASTM class F contains calcium of about 5% by mass, whereas class C contains more than 5% of calcium which tends to change in micro structure of concrete and properties of concrete. Class C fly ash normally comes out of coal power plants with higher lime content generally more than 15 % often as high as 30 % may give class C unique self-hardening characteristics. The Calcium content in fly ash plays a significant role in strength development and final compressive strength. Higher the Calcium content results in faster strength development and higher compressive strength. However, in order to obtain the optimal binding properties of the material, fly ash as a source material should have low Calcium content and other characteristics such as unburned material lower than 5%, Fe_2O_3 content not higher than 10%. The fly ash used in this study satisfies the requirement of IS: 3812-2003. The specific gravity and Finesses modulus (passing through 45 μm) of Fly Ash was 2.3 and 7.86.

Mix Proportions

In the present investigation M30 concrete is prepared with the water cement ratio 0.5. Concrete mixes are prepared by different proportions of cement replacing with Waste Paper Pulp Ash (0%, 5%,10%,15% and 20%) Fly Ash (0%, 5%, 10%,15% and 20%).

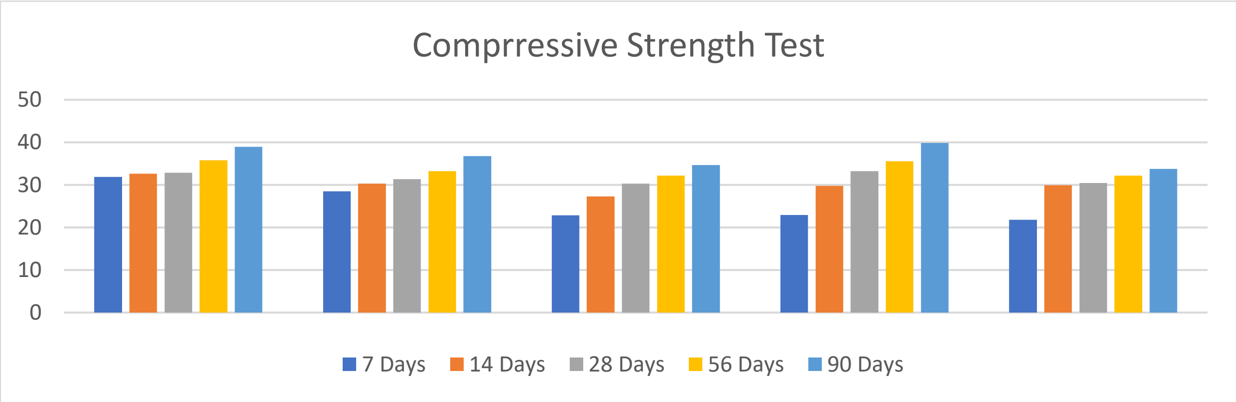
4. EXPERIMENTAL RESULTS

This chapter explains the experimental results which are obtained by different specimens with different proportions. The mechanical properties such as compressive strength split tensile strength, flexural strength is tested after 7 days, 14 days and 28 days.

Compressive Strength Test

The compressive strength test results of the concrete are the most important property in the mechanical properties of the concrete. The compression test results for the combination of both WPPA and Fly Ash are listed below.

Mix designation	Compressive strength (N/mm^2)				
	7 Days	14 Days	28 Days	56 Days	90 Days
WPPA0&Fly Ash0	31.85	32.6	32.86	35.77	38.92
WPPA5%&Fly Ash5%	28.47	30.33	31.33	33.24	36.75
WPPA10%&Fly Ash10%	22.83	27.33	30.3	32.17	34.65
WPPA15%&Fly Ash 15%	22.90	29.76	33.26	35.56	39.86
WPPA20%&Fly Ash 20%	21.77	29.9	30.46	32.15	33.75

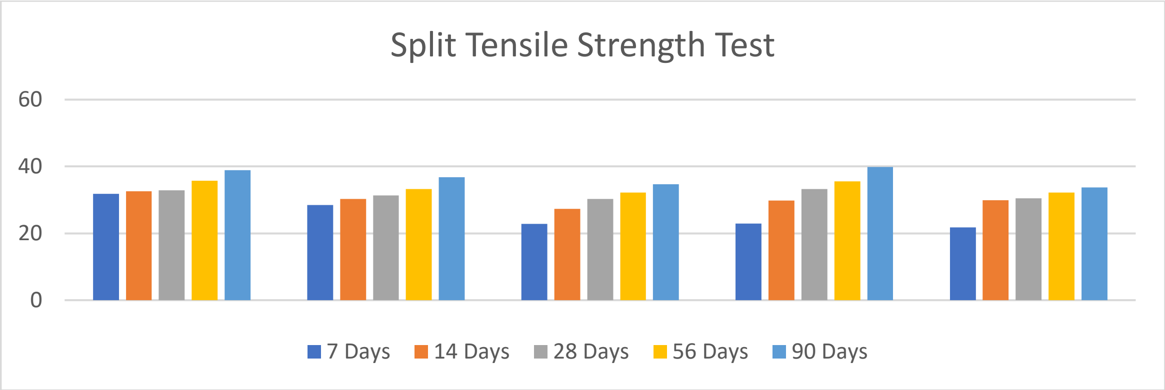


Effect of WPPA and Fly Ash of compressive strength

Split Tensile Strength

The Split tensile strength of the concrete tested for M_{30} concrete with 0%, 5%, 10% and 15% are tested and the results discussed in below. The Split Tensile strength test results of the concrete are the most important property in the mechanical properties of the concrete. The Split Tensile Strength test results for the combination of both WPPA and Fly Ash are listed below.

Mix designation	Split Tensile strength (N/mm^2)				
	7 Days	14 Days	28 Days	56 Days	90 Days
WPPA0&Fly Ash0	2.51	3.12	3.29	3.92	4.12
WPPA5%&Fly Ash5%	2.32	2.97	3.10	3.37	3.89
WPPA10%&Fly Ash10%	2.63	3.15	3.26	3.56	3.83
WPPA15%&Fly Ash 15%	2.92	3.56	3.93	4.20	4.56
WPPA20%&Fly Ash 20%	2.53	3.21	3.44	3.61	3.72

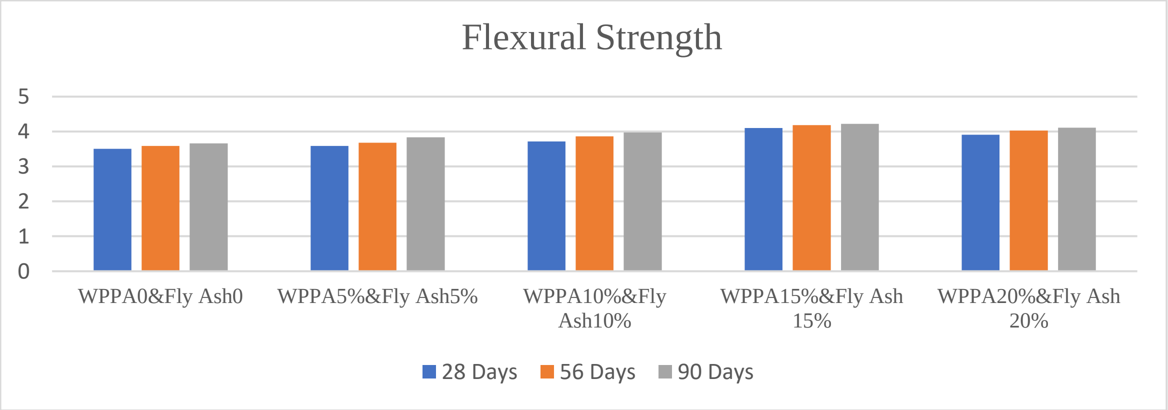


Effect of WPPA and Fly Ash of Split Tensile strength

Flexural Strength

The Flexural strength of M_{30} grade concrete mixes replacing OPC by Waste Paper Pulp Ash and Fly Ash at 0%, 5%, 10%, 15% and 20% is investigated.

Mix designation	Flexural Strength N/mm^2		
	28 Days	56 Days	90 Days
WPPA0&Fly Ash0	3.51	3.59	3.66
WPPA5%&Fly Ash5%	3.59	3.68	3.84
WPPA10%&Fly Ash10%	3.72	3.86	3.97
WPPA15%&Fly Ash 15%	4.10	4.18	4.22
WPPA20%&Fly Ash 20%	3.91	4.03	4.11



Flexural Strength for Different Mix Proportions

5. CONCLUSION

Based on Research for the study of behaviour of conventional by partial replacement of Waste Paper Pulp Ash and Fly Ash

1. Research on Mechanical Properties of waste paper pulp Ash and fly ash in OPC proportions as 0%, 5%,10%, 15%, and 20%. Maximum compressive strength is obtained as 15% WPPA and 15% of FA when compared with conventional concrete.

2. The compressive strength of M30 concrete increases with increase in the replacement of WPPA 15% with FA 15%.

3. The Split Tensile strength of M30 concrete increases with increase in the replacement of WPPA and Fly Ash as proportions as 0%,5%, 10%, 15%, 20%. Maximum Split Tensile strength is obtained as 15% of WAAP and 15% of FA when compared with conventional concrete.

4. The Flexural strength of M 30 concrete increases with increase in the replacement of WPPA and Fly Ash as proportions as 0%,5%, 10%, 15%, 20%. Maximum Split Tensile strength is obtained as 15% of WAAP and 15% of FA when compared with conventional concrete.

5. As I concluded that comparing with normal concrete the proportion 15% WPPA and 15% FA is to be optimum where the strength is proportionally increased.

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