

EXPERIMENTAL STUDY ON CONCRETE PREPARED BY PALM ASH AND RECYCLED AGGREGATE

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Abstract: In recent times recycling of waste plays important role in preserve natural resources. Recycling and reuse of construction and demolition waste is economical and eco-friendly. At the same time, palm ash produced during brick manufacture which is large disposal waste also used in this investigation. This project proposes the use of palm ash and recycled aggregate in concrete to improve the mechanical properties (i.e., compressive strength, split tensile strength and flexural strength) and concrete's durability. This investigation is done to assess the concrete property in which cement is replaced by palm ash and coarse aggregate is replaced by recycled aggregate. For concrete IS 10262:2009 method of mix design is adopted. Mix design of M-30 grade of concrete is adopted. Here experiment is done in two stages. At first stage cement is replaced by palm ash in different proportions, i.e. 10%, 15%, 20%, 25%, and 30% from which optimum palm ash replacement is obtained. Now in second stage by using optimum palm ash replacement level, coarse aggregate is replaced by recycled aggregate in various proportions, i.e. 10%, 20%, 30%, 40% and 50% is done to get optimum recycled aggregate level.

Key Words: Palm-ash, Recycled Aggregate, Super-plasticizer, Mechanical behavior.

1. Introduction

Modifications have been made from time to time to overcome deficiencies of cement concrete yet retaining the other desirable characteristics. Extensive research in the field of concrete technology has led to development of special types of concrete which are capable of eliminating, to a great degree these basic deficiencies.

Construction aggregate, is a broad category of coarse material used in construction, including sand, gravel, crushed stone, recycled concrete and geo synthetic aggregates. They are the most mined material in the world and are a component of composite materials such as concrete and asphalt concrete; they

serve as reinforcement to add strength to the overall composite material.

Due to the relatively high hydraulic conductivity value as compared to most soils, aggregates are widely used in drainage applications such as foundation and French drains, septic drains.

Field's, retaining wall drains, and road side edge drains and are also used as base material under foundations, roads, and railroads. In other words, aggregates are used as a stable foundation or road/rail base with predictable, uniform properties, or as a low-cost extender that binds with more expensive cement or asphalt to form concrete.

Palm ash is a by-product from thermal power plants contains huge amounts of silicon and aluminium oxides in amorphous state and accepted as a pozzolanic material. The use of supplementary cementing materials, like fly ash in concrete as attracted attention over the past decades. Apart from industrial waste, ashes from agricultural origin like rice husk, coconut husk, corn cob, peanut shell etc have been identified as supplementary cementing materials in many parts of world. In India, palm tree parts as palm fiber's and shells, are burnt at temperatures of about 800-1000⁰ C in brick manufacturing unit where palm ash are produced in huge amount. While some of it serves as low-value material for backfill or fertilizers, most of the palm ash is left or disposed as waste in landfills, causing environmental and other problems. Due to pozzolanic property, palm ash can be used as replacement for cement.

1.2 Objectives of the Study

The objective of the project is,

- To study the mechanical properties of concrete prepared by palm ash.
- To study the mechanical properties of concrete prepared by recycled aggregate with palm ash.

1.3 Advantages

The various advantages in the use of palm ash and recycled aggregate in concrete are,

- Heat resistant
- Reduces shrinkage effect
- More reliable
- Most economical

The best advantages of using palm ash and recycled aggregate in concrete is that they are available easily and eco-friendly.

1.4 Palm Ash

Palm ash is an agro-waste ash from which palm oil residue, as palm fiber and shells, are burnt at temperatures of about 800–1000⁰ C to produce steam for electricity generation in biomass thermal power plants. Palm ash is mainly produced in palm oil mills where from each oil palm tree fruit bunch, about 21% palm oil, 6–7% palm kernel, 14–15% fiber, 6–7% shell and 23% empty fruit bunch is produced. As a rough estimate, a single kilogram of palm oil results in 4 kg of dry biomass. With such large amounts of waste, researchers have been focused on the utilization of such waste in a number of aspects. Sometimes the wastes are still disposed in land-fills or left to rot on the palm oil mills.

1.5 Recycled Aggregate

Concrete recycling is a simple process. It involves breaking, removing, and crushing existing concrete into a material with a specified size and quality. The quality with RCA is very dependent on the quality of the recycled material used. Reinforcing steel and other items, if any, must be removed, and care should be taken to prevent contamination by other materials that can be troublesome, such as clay balls and asphalt, soil chlorides, glass, gypsum board, sealants, paper, plaster, wood, and roofing materials.

2. Literature Review

Weerachart Tangchirapat, Chai Jaturapitakkul, and Prinya Chindaprasirt (2009) specified the use of palm oil fuel ash as a supplementary cementitious material for producing high-strength concrete. Properties like the compressive strength, drying shrinkage, water permeability, and sulfate resistance were investigated.

Weerachart Tangchirapat and Chai Jaturapitakkul (2010) concluded the strength, drying shrinkage, and water permeability of concrete incorporating ground palm oil fuel ash(POFA). The POFA was ground to obtain two different finenesses:

coarse (CP) and fine(FP) at 10%, 20%, and 30% by weight of binder to cast concrete.

3. Material Properties and Experimental Investigation

3.1 General

Concrete is a composite product by mixing cement, aggregate and water. Each constituent has its own role in contributing strength to the composite element. The strength of the concrete and steel deformation of the beam defines the limits of strength of reinforced concrete beams. The cracking of the specimens and that of the ductile material like steel define the strength of a brittle material like concrete by yielding. Concrete being a poly phase material, its properties depend on the properties of the constituent materials. The description of various materials used for the investigation is given below.

3.1.1 Cement

Ordinary Portland Cement of 53 Grade locally available is used in this investigation. The Cement is tested for various properties as per the IS: 4031–1988 and found to be confirming to various specifications of IS: 12269–1987.

3.1.2 Fine Aggregate

Fine aggregate locally available clean, well graded, natural river sand having fineness modulus of 2.89 conforming IS: 383 – 1970 was used as the fine aggregate.

3.1.3 Coarse Aggregate

Coarse aggregate that was used in the concrete mix was broken stones of hard granite drawn from quarries in and around Perundurai. The maximum size of the coarse aggregate was 20 mm.

Test Results for Materials

Table 3.1. Properties of cement

Type	Grade of Cement Used	Standard Consistency	Specific gravity	Initial setting time in minutes	Final setting time in minutes
OPC	53 Grade	32.5 %	3.15	31	560

Table 3.2. Properties of Fine Aggregate

Type	Specific gravity	Fineness Modulus	Sand Confirming Zone
River Sand	2.60	3.225	Zone II

3.3 Water

Water according to IS 3025, water to be used for mixing process and curing must be free from injurious or deleterious materials. Potable water is considered satisfactory. In the present investigation, tap water was used for both mixing process and curing purposes.

3.4 Palm Ash

Palm ash is a type of agro-waste ash from which palm oil residue, such as palm fiber and shells, are burnt at temperatures of about 800–1000⁰ C to produce steam for electricity generation in biomass thermal power plants.

The specific gravity of Palm oil fuel ash was 1.65.

Table 3.3. Properties of Palm Ash

Components	% in POFA
Silica	21.81
Aluminium	2.76
Iron	3.20
Calcium	5.70
Magnesium	3.978
Potassium	3.23
Sodium	0.76
Phosphorus	3.58
Chlorine	0.34
Sulphur	1.28
LOI	2.99

3.5 Recycled Aggregate

Recycling and reusing of building wastes have been found to be an appropriate solution to the problems of dumping tons of debris accompanied with shortage of natural aggregates. The recycled aggregate used in this project are taken from the demolished concrete members in and around the campus. Use of recycled

aggregates in concrete can be useful for environmental protection and economical aspects. They are the materials for the future.

4. Mix Proportion

Water	Cement	Fine Aggregate	Coarse Aggregate
191.6 l/m ³	425.78Kg/m ³	535Kg/m ³	1163 Kg/m ³
0.45	1.25	2.73	2.73

5. Results and Discussions

5.1 Compressive strength

The compressive strength had been evaluated from the peak load obtained by crushing the specimen. The following table shows the compressive strength value of conventional concrete (CC) and Concrete with replacement.

Table 5.1. Compressive strength results with palm ash

% of palm ash replacement	Average compressive strength (N/mm ²)	
	7 days	28 days
0	17.88	29.74
10	16.71	27.65
15	18.92	31.44
20	20.34	33.68
25	19.25	32.28
30	18.41	30.74

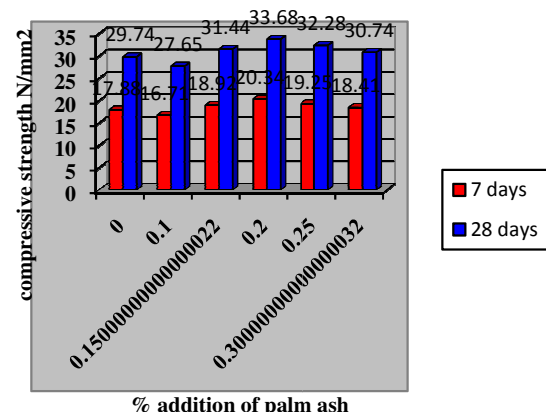
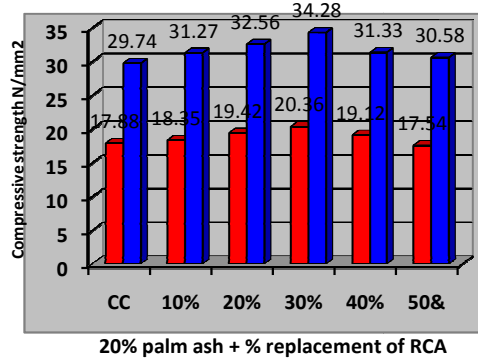
**Figure 5.1.** Compressive strength results with palm ash

Table 5.2. Compressive strength results with 20% palm ash & various % of recycled aggregate

% of palm ash replacement	% of recycled aggregate replacement	Average compressive strength (N/mm ²)	
		7 days	28 days
0	0	17.88	29.74
20	10	18.35	31.27
20	20	19.42	32.56
20	30	20.36	34.28
20	40	19.12	31.33
20	50	17.54	30.58

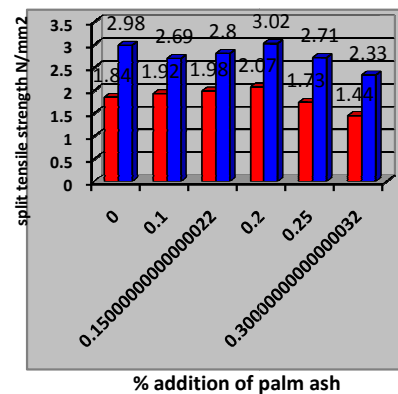
**Figure 5.2.** Compressive strength results with 20% palm ash & various % of recycled aggregate

5.2 Split Tensile strength

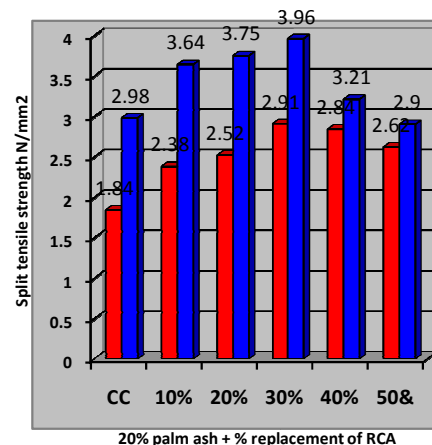
The following table shows the split tensile strength value of conventional concrete (CC) and Concrete with replacement.

Table 5.3. Split Tensile strength results with palm ash

% of palm ash replacement	Average split tensile strength (N/mm ²)	
	7 days	28 days
0	1.84	2.98
10	1.92	2.69
15	1.98	2.80
20	2.07	3.02
25	1.73	2.71
30	1.44	2.33

**Figure 5.3.** Split Tensile strength results with palm ash**Table 5.4.** Average Split Tensile strength results with palm ash

% of palm ash replacement	% of recycled aggregate replacement	Average split tensile strength (N/mm ²)	
		7 days	28 days
0	0	1.84	2.98
20	10	2.38	3.64
20	20	2.52	3.75
20	30	2.91	3.96
20	40	2.84	3.21
20	50	2.62	2.90

**Figure 5.4.** Split Tensile strength result with 20% palm ash & various % of recycled aggregate

5.3 Flexural strength

The following table shows the flexural strength value of conventional concrete (CC) and concrete with replacement.

Table 5.5. Flexural strength result with palm ash

% of palm ash replacement	Average flexural strength(N/mm ²)	
	7 days	28 days
0	1.23	3.82
10	1.15	3.62
15	1.26	3.95
20	1.61	4.26
25	1.47	3.97
30	1.09	3.77

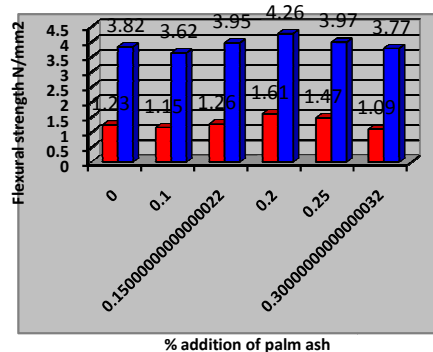


Figure 5.5. Flexural strength result with palm ash

Table 5.6. Flexural strength result with 20% palm ash & various % of recycled aggregate

% of palm ash replacement	% of recycled aggregate replacement	Average flexural strength (N/mm ²)	
		7 days	28 days
0	0	1.23	3.82
20	10	2.97	3.54
20	20	3.29	3.87
20	30	3.63	4.81
20	40	3.16	4.09
20	50	2.84	3.78

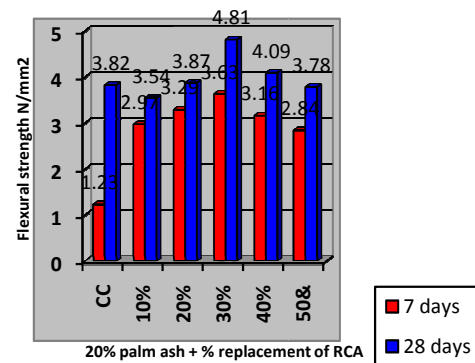


Figure 5.6. Flexural strength result with 20% palm ash & various % of recycled aggregate

6. Conclusions

- Compressive strength of 20% palm ash replacement for cement in concrete has found to be 13% increase in strength to that of conventional concrete.
- Split tensile strength of 20% palm ash replacement for cement in concrete has found to be 12% increase in strength, when compared to that of conventional concrete.
- Flexural strength of 20% palm ash replacement for cement in concrete has found to be 11% increase in strength, when compared to that of conventional concrete.
- Therefore 20% replacement of palm ash for cement is considered as optimum dosage which had been used for further process of recycled aggregate replacement for coarse aggregate in concrete.
- Compressive strength of 30% recycled aggregate replacement for coarse aggregate in concrete with optimum dosage of palm ash has found to be 15% increase in strength, when compared to that of conventional concrete.
- Split tensile strength of 30% recycled aggregate replacement for coarse aggregate in concrete with optimum dosage of palm ash has found to be 13% increase in strength, when compared to that of conventional concrete.
- Flexural strength of 30% recycled aggregate replacement for coarse aggregate in concrete with optimum dosage of palm ash has found to be 11% increase in strength, when compared to that of conventional concrete.
- Hence 20% of palm ash replaced for cement and 30% of recycled aggregate replaced for coarse

aggregate is found to be the optimum dosage for this project work.

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