

Experimental Study on Partial Replacement of Cement by Palm Ash

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Abstract

Cement is the essential construction material for making concrete which provide good binding among aggregates and also provide high strength. But cement releases high amount of CO₂ during manufacture. In order to reduce the environmental menace and also to enhance the property of concrete Palm ash based concrete are used. Palm ash based concrete containing palm ash as partial cement substitute. The partial replacement percentages are 10%, 20%, 30%. In this investigations properties such as compressive strength and durability strength of palm ash based concrete and conventional concrete are find out. Results are tabulated and discussed. The palm ash based concrete properties are also compared with the conventional concrete. The palm ash based concrete is very economical and also eco friendly concrete.

Keywords:

1. Introduction

In concrete, cement is the binding material. Which give good binding among aggregates and also give high strength. But for manufacturing one ton of cement the amount of CO₂ released is 1.2 ton which is hazard to environment. The amount of CO₂ released from cement manufacturing unit source contributes 8% among total CO₂ released to atmosphere. And also the amount of electricity required to produce one ton of cement be high. The cost of one bag of cement is also high. To minimize the electricity requirement and to reduce the amount of CO₂ released to atmosphere and for economic construction, cement is going to replace by waste material i.e., palm ash¹.

A palm oil mill produces a considerable amount of solid waste by-products in the form of fibers, nutshells and empty fruit bunches. These wastes are incinerated and remain as ash called palm ash. These ashes are dumped in to the field, but the ash does not have sufficient nutrients

to be used as fertilizer. It cause environmental degradation and also causes pollution. Therefore several investigations are going to utilize palm ash in good manner. The experimental investigation on palm ash shows the properties of palm ash is similar to the properties of cement. Therefore cement is replaced partially by palm ash. The replacement percentages are 10%, 20%, 30%. The concrete cubes are casted. The compressive strength at various age of curing is determined. The durability of concrete cubes is also determined. The results shows palm ash concrete give high strength, highly durable, economical and also eco friendly.

2. Materials Properties

Concrete is prepared with various percentage of palm ash as a binding material, cement, sand and coarse aggregate. Cement is added about 0% to 30% by weight of cement in concrete mix of M₂₀.

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2.1 Cement

Portland cement of 53 grade confirming to IS 8112-1976 is used in this project work. The specific gravity of cement is 3.15⁴.

2.2 Fine Aggregate

Natural River sand of size below 4.75 mm with specific gravity 2.6, fineness modulus as 2.36, and bulk density as 1415 kg/m³ was used.

2.3 Coarse Aggregate

Coarse aggregate of crushed stone of size 12 mm and below with specific gravity of 2.66, bulk density as 1383 kg/ m³ was used^{5,8}.

2.4 Palm Ash

Palm ash is an ash obtained by burning of palm fibres, palm bunch and palm kernel shells after extraction of palm oil in palm oil industry. It is a waste material. The palm ash having size less than 90 μ is used in this project. The specific gravity is 2.6^{2,6}.

2.5 Chemical Composition

The chemical composition for the palm ash used in this project is as follows.

Table 1. Chemical composition of Palm ash

Component	% Content
CaO	58
SiO ₂	14.16
Al ₂ O ₃	0.35
Fe ₂ O ₃	4.12
K ₂ O	0.32
SO ₂	0.53

Table 2. Quantities of materials required for different percentages of palm ash in concrete mix for one cube

Specimen	Cement (Kg)	Palm ash (Kg)	Fine aggregate (Kg)	Coarse aggregate (Kg)
Conventional concrete	1.29	0	1.88	4.128
Concrete with 10% PA	1.161	0.129	1.88	4.128
Concrete with 20% PA	1.032	0.258	1.88	4.128
Concrete with 30% PA	0.903	0.387	1.88	4.128

3. Experimental Details

3.1 Specimens Details

The number of specimens prepared for each percentage replacement of cement by palm ash for finding compressive strength is as follows.

Table 3. No. of Specimens casted-compressive strength

Specimen	No. of cubes
Conventional concrete	9
Concrete with 10% palm ash	9
Concrete with 20% palm ash	9
Concrete with 30% palm ash	9

Table 4. No. of Specimens casted-durability

Specimen	No. of cubes
Conventional concrete	3
Concrete with 10% palm ash	3
Concrete with 20% palm ash	3
Concrete with 30% palm ash	3

3.2 Testing of Cubes

At the end of curing period of 7, 14 and 28 days, take 2 cube of each proportion from curing tank³. Wipe the cube

Table 5. Compressive strength @ 7 days

S.No	Specimen	Average compressive strength
1	Conventional concrete	15.23
2	Concrete with 10% palm ash	20.56
3	Concrete with 20% palm ash	18.10
4	Concrete with 30% palm ash	16.12

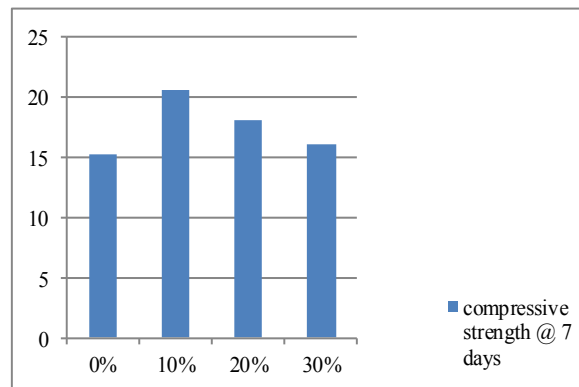


Figure 1. Compressive strength after water curing @ 7 days.

with clean cloth and measure the dimension on face of the cubes. Take the weight of the specimen. Then place the concrete cube in the compression plate under the compression machine. Apply the load gently over the cube. The ultimate load at which cube will fail under compression is noted down. From which compressive strength is calculated ^{7,9}.

Table 6. Compressive strength @ 14 days

S. No	Specimen	Average compressive strength
1	Conventional concrete	21.34
2	Concrete with 10% palm ash	29.56
3	Concrete with 20% palm ash	25.90
4	Concrete with 30% palm ash	23.14

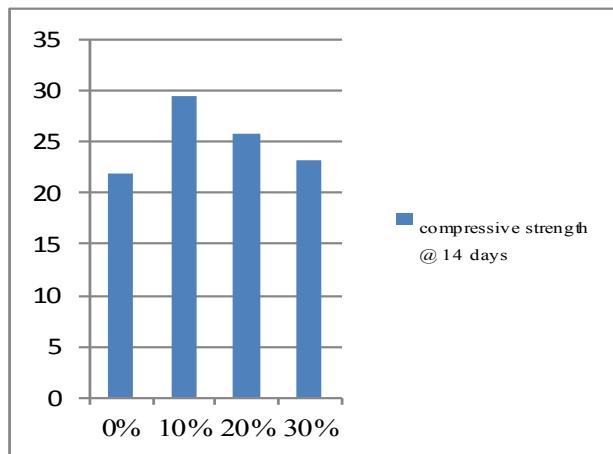


Figure 2. Compressive strength after water curing @ 14 days.

Table 7. Compressive strength @ 28 days

S. No	Specimen	Average compressive strength
1	Conventional concrete	25.41
2	Concrete with 10% palm ash	34.28
3	Concrete with 20% palm ash	30.16
4	Concrete with 30% palm ash	26.87

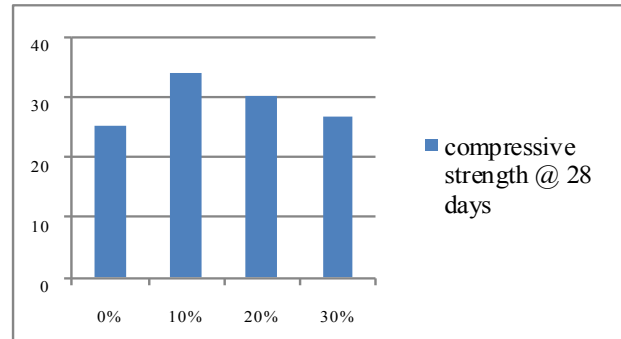


Figure 3. Compressive strength after water curing @ 28 days.

Table 8. Weight of concrete cubes after water curing @ 28 days

Specimen	No. of cubes	Average weight of cube in kg
Conventional concrete	3	8.41
Concrete with 10% palm ash	3	8.32
Concrete with 20% palm ash	3	8.14
Concrete with 30% palm ash	3	8.06

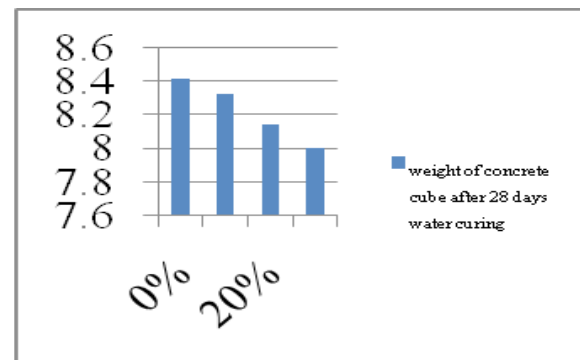


Figure 4. Weight of concrete cube after 28 days water curing.

Table 9. Compressive strength after acid curing

S. No.	Specimen	Average compressive strength
1	Conventional concrete	25.26
2	Concrete with 10% palm ash	33.91
3	Concrete with 20% palm ash	29.51
4	Concrete with 30% palm ash	25.63

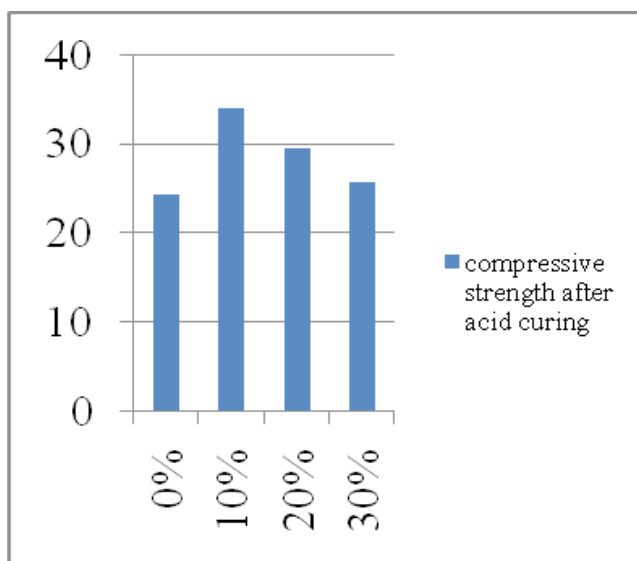


Figure 5. Compressive strength after acid curing.

Table 10. Weight of concrete cube after acid curing

Specimen	No. of cubes	Average weight of cube in kg
Conventional concrete	3	8.401
Concrete with 10% palm ash	3	8.305
Concrete with 20% palm ash	3	8.133
Concrete with 30% palm ash	3	8.052

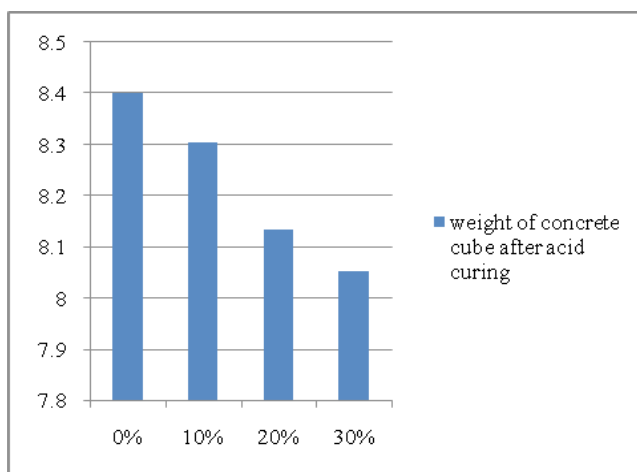


Figure 6. Weight of concrete cube after acid curing.

4. Conclusion

The following conclusions are drawn from this investigation;

- Partial replacement of cement by palm waste in concrete causes variation in strength.
- Compare to conventional concrete, the palm ash shows high strength co.
- Durability (acid resistance) of palm ash concrete is also higher than the conventional concrete.
- Replacement reduces the density of concrete cubes than conventional concrete.
- By adding palm ash in concrete reduces the pollutant due to cement and palm ash in environment and consider as eco-friendly material.

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