PARTIAL REPLACEMENT OF FINE AGGREGATE WITH VARIOUS WASTE MATERIALS

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Abstract

In the present paper an experimental investigation is carried out on the partial replacement of fine aggregate with fly ash, M-sand and crumb rubber. The natural material are found out to be have a shortage and therefore the alternative materials like fly ash, manufactured sand and rubber powder should be used. This study consist of experimental program on M20 Grade of concrete with different percentage replacement of fine aggregate with materials like fly ash, m-sand, and rubber powder. The fine aggregate are replaced by manufactured sand up to 30% replacement and due to this compressive strength of concrete increases. It is observed that the mix of fly ash and m-sand when uses up to 30% then the compressive strength increases up to good extent.

Key Words : Fine aggregate, Fly ash, Manufactured sand and Crumb rubber

1. Introduction

Manufacturing of concrete consist of fine sand and it is most widely used material. The primary source of natural sand is the river sand. There is a shortage of these natural resources and therefore the other source has to be finding out. The fly ash is a by-product of thermal power plant. Similarly the manufactured sand instead of natural sand is the good alternative material. Crushing of stone or natural gravel is the manufactured sand and it is an alternative material to natural sand. This M-sand has the similar physical properties as that of the natural sand. The use of this material is environmentally safe and it imposes no threat to human mankind [1], [4].

There is another material which is waste tyres and it is generated annually and stock piled but in uncontrolled manner, therefore creates serious environmental problems. Nowadays tyre waste is increasingly annually as the motor vehicles are increasing rapidly. If used in the powdered form then this can be used as good alternative material.

The effects of replacement of fine aggregate with only high percentages of fly ash (class-F) are evaluated for the properties of concrete [2]. Also the mortar in which fly ash as partial replacement of sand by weight and volume is experimentally carried out. Cost saving was around 58% as compared to the plain mortar [3]. The properties of concrete are studied with the utilization of fly ash and 10% to 30% fly ash were replaced [5],[6].

The experiments were performed on the concrete in which the crumb rubber was used as partial replacement of fine aggregate. These experimental results were confirmed about the rubber concrete specimen that exhibited good performance in ductility as compared to the normal concrete [8].

2. Materials

The different materials were used in the experimental investigations and they are explained below:

2.1 Cement

The ordinary Portland cement of 53 grade is used as per the specification given in IS 12269-1987(9). The properties are mentioned in the Table No.1

Table 1: Properties of Cement

Sr. No.	Properties	Result
1	Initial Setting time	35min
2	Specific Gravity	3.148
3	Fineness Modulus	1.5%

2.2 Fine Aggregate

The natural sand was used in the present experimental program and specification followed as per the IS 383-1987. The river sand was locally available and the bulk density of 1860 Kg/m³ was used. The properties are mentioned in the Table No. 2.

Table 2 : Properties of Fine Aggregate

Sr. No.	Properties	Result
1	Water absorption	0.50%
2	Specific Gravity	2.55
3	Fineness Modulus	2.36%

The sieve analysis was carried out on the natural sand as per the IS 383-1987. The quality of sand is to be checked and therefore this test is very important. The percentage passing of sand through different sieve are mentioned in the Table No. 3.

Table 3 : Sieve Analysis of Natural Sand

Sieve Size	Natural sand % Passing
4.75mm	98
2.36mm	96
1.18mm	78
600µm	51
300 µm	26
150 µm	7

2.3 Coarse Aggregate

The coarse aggregate as per the specifications given in IS 383-1987 is used and the properties of it are mentioned in the Table No. 4.

Table 4 : Properties of Coarse Aggregate

Sr. No.	Properties	Result
1	Water absorption	2.4%
2	Specific Gravity	2.63
3	Fineness Modulus	6.75%

2.4 Water

The water used for experiments was potable water.

2.5 Fly Ash

The properties of fly ash are mentioned in the Table No. 5.

Table 5 : Properties of Fly Ash

Sr. No.	Properties	Result
1	Density	2.17 g/cm ³
2	Moisture content	2%
3	Colour	Grey
4	Sp gravity	1.66-2.55
5	pH	6.0-10.0

2.6 Manufactured sand

Manufactured sand is used for partial replacement to natural sand and the properties are mentioned below.

Table 6 : Properties of M-sand

Sr. No.	Properties	Result
1	Water absorption	5.6%
2	Specific Gravity	2.75
3	Fineness Modulus	2.85%

Table 7 : Sieve Analysis of M-sand

Sieve Size	M-Sand % Passing
4.75mm	99.78
2.36mm	87.14
1.18mm	63.12
600µm	45.75
300 µm	25.50
150 µm	7.98

2.7 Crumb rubber

The properties of crumb sand are mentioned in the Table No. 8.

Table 8 : Properties of Crumb Rubber

Sr. No.	Properties	Result
1	Water absorption	1.7%
2	Specific Gravity	0.89
3	Fineness Modulus	2.62%

Table 9 : Fineness Modulus

Type of Sand	Fineness Modulus Range
Fine Sand	2.2 - 2.6
Medium Sand	2.6 - 2.9
Coarse Sand	2.9 - 3.2

3. Result

For M20 grade of concrete the different cubes are casted. In the concrete cubes the fine aggregates are replaced by the different materials like fly ash, manufactured sand and rubber with various percentages. After curing of 7, 14 and 28 days the cubes are tested properly. The slump test is performed on the fresh concrete to check the workability of concrete.

Slump test result is conducted as follows:

The M20 grade of concrete is prepared with mix proportion 1:1.5:3 and water cement ratio 0.5.

Graph 1 : Slump Value For Rubber Mixes

From the graph no.1 it is observed that the slump value for 0% is higher and as the percentage of rubber is increased from 0% to 10%, 20% & 30% the value of slump is decreased. Therefore the workability is also decreased.

Graph 2 : Slump Value For Fly Ash Mixes

The slump value for 0% fly ash is highest as observed from the graph no.2. The percentage of fly ash if goes on increasing from 0% to 10%, 20% and 30% then the slump value goes on decreasing and the workability is also decreases.

Graph 3 : Slump Value for M-sand Mixes

From the graph no.3 it is observed that when the manufactured sand is 0% then the value of slump is lower but the percentage of it is increased up to 10% then the value seemed to be increasing. Then still increasing the percentage of m-sand then it is found that after 10% the value is decreasing and the workability is also decreasing as compared to the 0% m-sand.

Graph 4 : Slump Value for (m-sand + Fly Ash) Mixes

As per the graph no.4 when the mixture of fly ash and m-sand is used in the concrete mixes, from the graph, then it is found that up to 10% when the mix is used then the value of slump goes on increasing but as the percentages of mix in increased from 10% to 20% and 30% then the value of slump is decreases, the workability is also decreases.

Graph 5 : Variation Of Compressive Strength for Rubber Mixes

From the above graph no.5 it is cleared that the more the percentage of rubber then lesser the compressive strength. Therefore for 0%rubber in the concrete then the compressive strength results are good but the percentages when increased from 0% to 10%, 20% and 30% then the compressive strength is decreased and the concrete is not suitable for higher loads. It can be concluded that only rubber should not be added to the concrete as the compressive strength is not increased.

Graph 6 : Variation Of Compressive Strength for Fly Ash Mixes

From the graph no.6 it is observed that as the percentages of fly ash if increased from the 0% to 10%, 20% and 30% then the compressive strength increases. As the compressive strength of 30% fly ash is found to be slightly higher than the 0% fly ash then the fly ash can be used in the concrete since it avoids increase in carbon dioxide level in the atmosphere.

Graph 7 : Variation Of Compressive Strength for M-sand Mixes

From the graph no.7 it is observed that as the percentages of m-sand if increased from the 0% to 10%, 20% and 30% then the compressive strength increases. As the compressive strength of 30% fly ash is found to be higher than the 0% m-sand then the fly ash can be used in the concrete.

Graph 8 : Variation Of Compressive Strength for (fly Ash+ M-sand) Mixes

From the above graph no.8 it is observed that the mix of fly ash and m-sand when uses up to 30% then the compressive strength increases up to good extent. Therefore the mix of it can be used as it has the advantage on the cost, cost decreases if used properly.

4. Conclusion

1. The slump value for 0% is higher and as the percentage of rubber is increased from 0% to 10%, 20% & 30% the value of slump is decreased.
2. The percentage of fly ash if goes on increasing from 0% to 10%, 20% and 30% then the slump value goes on decreasing and the workability is also decreases.
3. When the manufactured sand is 0% then the value of slump is lower but the percentage of it is increased up to 10% then the value seemed to be increasing.
4. When the mixture of fly ash and m-sand is used in the concrete mixes, from the graph, then it is found that up to 10% when the mix is used then the value of slump goes on increasing.
5. The percentages when increased from 0% to 10%, 20% and 30% then the compressive strength is decreased and the concrete is not suitable for higher loads.
6. It is observed that as the percentages of fly ash if increased from the 0% to 10%, 20% and 30% then the compressive strength increases.
7. It is observed that as the percentages of m-sand if increased from the 0% to 10%, 20% and 30% then the compressive strength increases.
8. It is observed that the mix of fly ash and m-sand when uses up to 30% then the compressive strength increases up to good extent.

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