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Performance Of Concrete With Partial Replacement Of Sand By Dry Sewage Sludge

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Abstract

In many countries, sludge is a serious problem due to its high treatment costs and the risks to environment and human health. The disposal of sludge is more tedious and it provides various difficulties, hence it is necessary to find out alternative disposal method. The study investigated the use of sewage treatment sludge incorporated with fine aggregate in concrete. The purpose of this study is to find an alternate source for fine aggregate. Since the river sand is found to be in limited availability and its cost is also high. In this study the concrete were produced by partially replacing the fine aggregate with dry sludge to the proportions of 20%, 25%, 30% by dry weight and compared with regular concrete. Natural fibres are added to improve the concrete strength. The concrete cubes, cylinders and beams were casted. The compression, tensile and flexural strength were taken at the end of 7 and 28 days. The results shows that concrete exhibits better strength upto 25% replacement of fine aggregates by dry sludge.

1.1 INTRODUCTION

India has current population of 1.37 billion with average sewage disposal is about 62000 MLD where only 37% is treated as fresh water. This sludge has disposal problems in order to reduce that reuse of that resources are about to tested with different percentage of replacement. This may drastically reduce the sludge content and even the cost of concrete. Sludge is a product which is obtained during the treatment of waste water. The characteristic of sludge differ upon the region and the method of treatment. Sludge is formed after undergoing various steps such as stabilization, composting, anae
robic digestion, thickening, dewatering and drying. These sludge contains maximum amount of nitrogen content and so it is majorly used for agricultural purpose. This practice is considered unsatisfactory because of the presence of pathogens in the sludge in high numbers. There has been no thorough study, however, which has shown that there is an increase in the risk of acquiring illnesses associated with pathogens in the raw sludge when proper handling procedure and non entry to the land following application is observed. Reuse of composted sludge as a soil conditioner in agriculture and horticulture returns carbon, nitrogen, phosphorus and elements essential for plant growth back to the soil. Less chemical fertilizers are required and the organic carbon helps to improve soil structure for soil aeration, water percolation and root growth. The nitrogen and phosphorus are also released gradually for plant uptake compared to the more soluble chemical fertilizers. The potential of leaching of the nutrients to ground or surface water by rainfall run-off is much reduced. Pathogens and heavy metals can however, limit the

reuse of sludge. Pathogens should be reduced to levels that do not pose health hazards to workers handling the sludge, potential health hazards from the spreading of helminth eggs and from horticultural produce contaminated by pathogens. Stabilized sludge, which has been dewatered and dried on sand beds to attain low moisture content, can meet the same conditions. Heavy metals and toxic chemicals are difficult to remove from sludge. Preventing these chemicals from entering the wastewater or sludge should be the aim of wastewater management for sludge intended for reuse in agriculture or horticulture. Reuse may still be possible for purposes such as mine site rehabilitation, highway landscaping or for landfill cover. Sludge that has been conditioned for reuse is called 'bio solids'. Conversion of sludge, which is heavily contaminated by heavy metals or toxic chemicals, to oil is technically feasible. A full-scale plant is operating in Perth, Western Australia. The conversion is by a pyrolysis process, heating dried sludge to a high temperature in the absence of oxygen or with a controlled amount of oxygen. Capital and running costs of oil from sludge process are high. Final or ultimate disposal of sludge, which cannot be reused, is by land filling or incineration. Since sludge for land filling usually contains heavy metals or toxic chemicals, lining of the landfill with clay or plastic liner may be required to prevent contamination of groundwater. Incineration of sludge is by a multiple hearth furnace or fluidized bed furnace. Energy input is required to dry the sludge before combustion is self-sustaining. Combustion flue gases usually need treatment to meet air pollution control standards. Investment and operating costs are high. Due to these various reasons replacement of sludge in fine aggregate was considered.

1.2 MATERIALS USED

1. Cement (Grade 53)

2. Coarse aggregate

3. Fine aggregate

4. Water

5. Dry sewage sludge (Passes through 4.75 mm and retained in 2.36 mm IS sieve)

6. Natural fibres

1.2.1 NATURAL FIBERS

Kenaffibre : Kenaffibre has emerged as an important plant cultivated in world countries and has been regarded as an industrial crop. It has a great potential for replacing synthetic fibre such as glass fibre. The use of kenaffibre can provide mechanical properties such as tensile strength, comparable to those of synthetic fibres with lower density than traditional materials, resulting in light weight and eco friendly.

Fig 1.1 Kenaf Fiber

Pineapple leaf fibre : Pineapple leaf fibre(PALF) is one of the waste material in agricultural sector. Commercially pineapple fruits are considered as waste materials of fruit which is being used for producing natural fibres. The chemical composition of PALF constitute holocellulose , lignin, ash. This fibre has a tremendous mechanical properties and can be applied in making of reinforced polymer composites

Fig 1.2 Pineapple Leaf Fiber

Palmyra fibre : Palmyrafibre is a natural fibre that derive from the treatment of leaf sheets of Palmyra palm and is found in southern and eastern India. As with most of the vegetable fibre it has good resistance to heat and most chemicals. When it is mixed with concrete it increases the flexural strength of the concrete.

Fig 1.3 Palmyra Fiber

Bamboo fibre : Bamboo is one of the natural fibrecatagorised by large ratio of strength to weight and its ease of work with simple tools. It is one of the rapidly growing natural reserves also it is easily and locally available. The bamboo fibre reinforced concrete has high tensile and flexural strength. The compressive strength of the concrete doesn't has much effect upto 28 days, when the concrete is tested in 50 days the strength has been doubled.

Fig 1.4 Bamboo Fiber

SLUDGE

Sewage sludge is a product of waste water treatment. Disposal of dry sludge have been an important problem of sewage treatment plants due to environmental restrictions. The material is not usually permitted to be buried in soil or used as agricultural fertilizer because of high heavy metal contents. Some investigations performed on application of these materials in construction materials especially concrete mix designs

Fig 1.5 Dry Sludge Sewage

Table 1.1 Dry Sludge Characteristics

SL.NO	DESCRIPTION	UNIT
1	Total suspended solids	6ppm
2	Volatile suspended solids	48 ppm
3	Specific gravity	1.56
4	Shear strength	59.5 KPa
5	Permeability	16.6cm/H

TABLE 1.2 MIX PROPORTIONS

% of sludge replacement	Weight of Cement	Weight of C.A	Weight of F.A	Weight of dry sludege	% of fiber added to volume
0%	8.47kg	25.01 kg	16.5 kg	0	0%
20%	8.47kg	25.01 kg	13.2 kg	3.3 kg	0.5%
25%	8.47kg	25.01 kg	12.37 kg	4.12 kg	0.5%
30%	8.47kg	25.01 kg	11.55 kg	4.95 kg	0.5%

1.3 RESULTS

Table 1.3 28 Day Results For Cube Specimen

SL.NO	% of replacement of sand by dry sludge	Compressive strength (N/mm2)	Tensile strength (N/mm2)
1	0%	34.6	3.45
2	20%	32.8	3.48
3	25%	30.7	3.58
4	30%	29.8	3.55

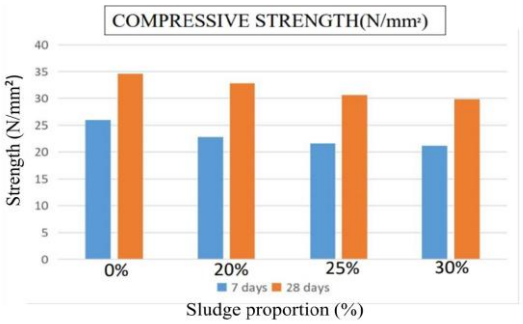

Fig 1.6 Compressive Strength Results

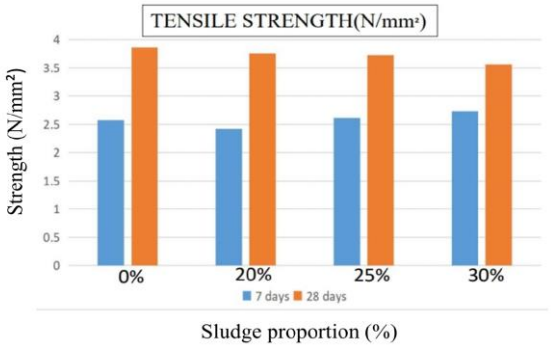

Fig 1.7 Tensile Strength Results

1.4 CONCLUSION

Sludge can be used as an effective replacement of fine aggregate and it can be replaced with 25% in concrete with addition of fibres. By the usage of waste sludge in concrete we have made concrete more economical ,durable and eco- friendly. Thus the usage of sludge reduces the usage of sand. Hence replacement of sludge for fine aggregates is suitable upto 25% replacement.

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