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Partially Replacement of Sand by Artificial Sand in Ferrocement used in Road Construction

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Abstract - *India is a vast Country, the economic prosperity of the country depends upon its products and economic transportation to the marketing centres. The roads also play an important role in the defence of our country as well as in cultural progress. India is a country of village, but more attention is given to the roads of national importance than the village roads. .As compared to density of population the road density is less. India's is village country due to more attention on national highway .The village roads are not well developing as compare to density of population. In India the density of road network are very less due to some financial, political & required time consuming reasons therefore we have to introduce our research which include that the thickness of the rigid pavement are reduces & with also cost & Time has less reduce.*

According to above information we have construct the some specimen(1:3)Proportion in three different sizes & conduct compression & flexural test on that specimen & compare to conventional concrete pavement (M40 Grade) using in rigid pavement

The sizes of specimen are given, (1) 900x 250x 75 mm, (2) 900 x 250 x 100mm, (3) 900 x 250 x 125mm, for flexural test & 150 x 150 x 150 mm cube for compression test & also conduct various tests on materials such as workability, compaction factor, sieves analysis, impact value test consistency test.

Artificial sand term used for aggregate material less than 4.75mm and which are processed from crushed rocks or gravel. Due to booming of construction activity in our country natural sand resource are increasingly depleted and its cost is becoming increasingly high. This research was, there for conducted to study the influence that artificial sand have in compressive strength of concrete to compare the cost of different mix composition and to assess the prospect of using artificial sand as replacement of natural sand in India.

Initially, different natural sand and artificial sand sample is used in the concrete mixes were collected and their physical properties were studied. Different concrete mixes having mix proportion for both natural and artificial sand as a fine aggregate were prepared using a water cement ratio is 0.45

It has been found also that use of artificial sand is more suitable for high strength concrete production. Therefore, It can be concluded from the finding of this research that when that availability of natural sand is scarce or in cities where the price of natural sand is as expensive as manufactured one, artificial sand concrete mix is a viable and better alternative to the use of natural sand

***Key Words*: 1. ferrocement, 2.artificial sand, 3. Reduced thickness, 4. Concrete Road Pavement, 5. Reduce cost.**

1. INTRODUCTION

Transportation Engineering is a branch or basic area of civil engineering which deals with design, development construction and maintenance of roadway, railways, airports, harbors, docks, tunnels and bridges. In short, it is the technology by which a proper communication facility is planned, designed and constructed for easy transport of human being and goods from one place to another.

1.1 NECESSITY OF TRANSPORTATION:

Transportation is the means to carry people and goods from one place to another. This has become very important in each stage of human civilization. If the present means of transportation were not developed, situation of the world would be totally different. Transportation has contributed much to the development of economic, social, political and cultural fields and uplifting their condition. Speedy industrialization is impossible without development of transportation. It is unavoidably necessary to promote transport system for the proper development of agricultural sector and rural areas. Without development of transportation neither mass production nor distribution is possible.

1.2 RIGID PAVEMENT :

Road construction is the major activity in India which is one of the important factors for nation's growth and improvement. To increase the growth of nation various techniques are develop in construction of roads. This study include introduction of rigid pavement with Partial replacement of sand by artificial sand in Ferrocement which is one of advanced technique to construct road pavement. Therefore now, Introduce new topic name is **Partial replacement of sand by artificial sand in Ferrocement used in road pavement**

What is Ferrocement: The concept of the ferrocement is a system of reinforced mortar (cement, sand and water) applied over layers of metal such as chicken wire or woven or expanded metal (iron) mesh or fibers and possibly closely spaced small-diameter steel rods such as rebar. It is used to form relatively thin **(25mm to 70mm)**, hard, strong forms in many shapes for such applications as hulls for boats, shell roofs, and water tanks.

But we have made slight changes in concept of ferrocement, **which include replacement of sand partially by artificial sand with wire mesh and increasing thickness (above 75mm)**

Constituent materials in Road Pavement:

1. Cement
2. Fine aggregate
3. Water
4. Reinforced wire mesh

Cement: We used ordinary Portland cement of 53 grades as per IS 1489:1991 standards. Cement is a key to infrastructure industry and is used for various purposes and also made in much composition for a wide variety of uses. Cement may be named after the principal constituents, after the intended purpose, after the object to which they are applied or after characteristic property.

Ordinary Portland cement is suitable for general concrete construction when there is no. exposure to sulphates in the soil the standard required that it is made from 95 to 100 percent of Portland cement clinker and 0 to 5 percent of minor additional constituents

Table No.: 1 Consistency test of cement paste

Observation no	1	2	3
Weight of water added (W2) gm	108	110	116
Penetration of plunger from bottom in mm	11	09	08
% water by weight = W2/W1 X 100	27.4	28	29

Fine aggregate: Locally available fine sand is used as per IS 2386-1963 And IS 383- 1970 having grading zone II. In fine aggregate only **30 % Natural sand** are used and remaining **70% artificial sand** of fine aggregate are uses in road Pavement

The sand is sieved using sieves of sizes 10mm, 4.75mm, 2.36mm, 1.18mm, 600micron, and 150 micron, these size fraction are combined in equal proportion grading complying with standard sand as per IS 650:1991. The physical properties of both natural and artificial sand are also show in Table.

Table No.: 2 Physical properties of natural and artificial sand

Property	Artificial sand	Natural sand	Test method
Specific gravity	2.54-2.60	2.60	IS 2386(Part III) 1963
Bulk relative density (Kg/m³)	1600	1460	IS 2386(Part III) 1963
Absorption (%)	1.20-1.50	Nil	IS 2386 (Part III) 1963
Moisture content (%)	Nil	Nil	IS 2386 (Part III) 1963
Sieve analysis	Zone II	Zone II	IS 383-1970

Table No.: 3 Result of Sieve analysis

Sample (Kg.)	Fineness Modulus
Course aggregate (5Kg)	**8.03**
Artificial sand (1Kg)	**7.5**
Natural sand (1Kg)	**3.07**

Table No.: 4 Result of Impact test on artificial sand

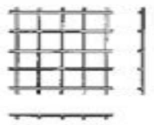
Sr. No.	Item	Test
1	Weight of oven dried sample(W1) gm	600 gm
2	Weight of fraction passing 2.36mm IS sieve (W2) gm	150gm
3	Weight of fraction retained 2.36mm IS sieve (W2) gm	450gm
4	A/V= (W2 / W1)X 100	25

Table No.: 5 Workability and compaction factor for Sand Replace Concrete and Conventional Concrete

Sr. No.	Workability Tests	W/C Ratio	Conventional Concrete	Sand Replace Concrete
1.	Slump (mm)	0.45	7.00	0.00
2.	Compaction Factor	0.45	0.826	0.823

Water: A tap water, which is supplied from the Municipal Corporation Yeola water supply and sewerage authority, is used for all concrete mix. The **water cement ratio is 0.45** as standard for concrete pavement. Portable water is used, having pH ranging from 6.2 to 8.2.

Wire Mesh: Mesh for ferrocement is commonly in the form of layers of continuous fabricated single strand filaments. We are using the two types of mesh, welded steel square mesh of 25mm gauge and woven mesh of 18mm gauge (chicken mesh), as per ACI 549R-97.



Square welded wire mesh

2. LITERATURE REVIEW 2

Kumar, A. (2005),[1] "Ferrocement box section-viable option for floor and roof of multi-storey building". A 5m x 9m size interior panel of a framed structure has been designed as panel-slab co instruction, flat slab construction and using Ferrocement box sections for 5 kN/m2 live load. The self-weight, floor/ roof height and cost of these options have been compared. It is found that the flat slab option is comparable in weight to the panel-slab option, about 58.2% less in floor height and 17.7% costlier than the conventional panel and slab construction. The Ferrocement box section alternative is found to be 56.2% less in weight, comparable in floor height and 15.6% cheaper than the panel - slab construction. The Ferrocement box sections being light in weight need less strong supporting structures. Being a precast product, they also increase speed of construction and can be used in bad weather conditions. Comparison of Design On the basis of costs for all the three options it is found that the flat slab option and the Ferrocement box section option are costlier and cheaper than the panel-slab construction by 17.7% and 15.6% respectively. It also shows the dead weight of the three options. A comparison of weights shows the relative values are to be 100%, 101.1% and 43.8% for the panel-slab option, flat slab and Ferrocement box sections option respectively. A comparison also shows the depth of the panel-slab and Ferrocement box section options have comparable floor depths (910mm), while the flat slab option is thinner than the previous two options (380mm). In panel-slab type construction and flat slab type option, the cost of formwork varies from 12 to 18 percent of the material cost while very nominal formwork is required for Ferrocement precast box sections. Also repeated use of the formwork reduces the cost of the formwork. The small cost of formwork, makes the adoption of Ferrocement box sections a financially attractive option [2].

Kohler, E. *et.al* (2007),[2] "Precast Mortar Pavements and Results of Accelerated Traffic Load Test" This paper summarizes experiences around the world with the use of precast slabs for pavement rehabilitation. The life of this system of precast slabs, when used as detailed for this test, is estimated to be between 142 and 242 million ESALs. These numbers result from estimated traffic applied in section 2, which did not fail, and in section 1, which failed under very high load levels. The failure mechanism in this system of precast slabs was no different than failure in cast-in-place jointed mortar pavements. Corner cracks, which are the result of loss of support, created conditions indicative of the end of usable pavement life. It must be taken into account that accelerated pavement testing differs in some ways from years of live traffic loading, in particular with regard to wheel load conditions with the HVS and the effect of the environment. Faster moving trucks could cause more pumping than was observed in the experiment, especially if joint seals are not maintained and are left to deteriorate over time. Finally it should be emphasized that this test was conducted on slabs of a specific thickness reinforced with a unique pattern of reinforcing steel and supported, by choice, upon un-bound bedding material. Use of a cement-treated or asphalt-emulsion–treated mortar sand bedding material may have greatly reduced, if not eliminated, the pumping of fines that occurred under the very severe wetting conditions in the test, potentially altering the results [6].

Mahmood, M. *et.al* (2008),[3] "Flexural Behavior of Flat and Folded Ferrocement Panels". The paper describes the results of testing folded and flat Ferrocement panels reinforced with different number of wire mesh layers. The main objective of these experimental tests is to study the effect of using different numbers of wire mesh layers on the flexural strength of folded and flat Ferrocement panels and to compare the effect of varying the number of wire mesh layers on the ductility and the ultimate strength of these types of Ferrocement structure. Seven Ferrocement elements were constructed and tested each having (600x380mm) horizontal projection and 20mm thick, consisting of four flat panels and three folded panels. The used number of wire mesh layers is one, two and three layers. The experimental results show that flexural strength of the folded panels increased by 37% and 90% for panels having 2 and 3 wire mesh layers respectively, compared with that having single layer, while for flat panel the increase in flexural strength compared with panel of plan mortar is 4.5%, 65% and 68% for panels having 1, 2 and 3 wire mesh layers respectively. The strength capacity of the folded panels, having the particular geometry used in the present study, is in the order of 3.5 to 5 times that of the corresponding flat panels having the same number of wire mesh layers [1].

Kathleen, Hall (2010),[4] "Full-depth Repair of Jointed PCC Pavements Cast-in-Place and Precast Procedures". During the 1960s in Michigan (Simonsen 1972) and Virginia, jointed reinforced mortar pavements were constructed with panel lengths of up to 30.48 m (100 ft) and 18.75 m (61.5 ft), respectively. While a number of factors contributed to early deterioration of these pavements, a principal mode of failure was transverse joint "blowups" due to large seasonal and daily joint movements, loss of joint sealing material, intruded incompressible fines, and, typically on very hot summer days following an afternoon rain shower, the sudden compressive rupture and upward thrusting of mortar at the transverse joint. In these cases, the pavement was immediately closed to traffic and required rapid emergency repair to restore it to service. Alternative full-depth repair methods included asphalt patches, very-high-early-strength mortar and precast reinforced mortar panels. The successful use of precast reinforced mortar panels for "temporary" pavement repairs during the 1970s in Michigan and Virginia is a testament to an innovative practice that has found renewed interest during the last decade, primarily due to limited work windows resulting from increased traffic volumes [7].

Tayabji S. *et.al* (2013),[5]"Precast mortar pavement: Technology overview and technical consideration". This paper presents an overview of precast mortar pavement technology as it is practiced in the United States. The paper also addresses some technical considerations related to the design of precast mortar pavements. The load transfer provision at transverse joints and the support condition under the precast mortar panels are two critical design features and must be properly addressed for any precast mortar pavement. Precast mortar pavement technology is maturing and continues to evolve. It is expected that innovations in this technology will ensure a permanent place for the application of the precast mortar pavement technology for durable, rapid repair and rehabilitation of existing pavements and will help reduce the cost of panel fabrication and installation [5].

Research gap: As referring various papers we came to know that, work related to artificial sand use in Ferrocement for construction of concrete road pavement. Also work related to reduction in thickness of concrete road section which is not done yet. At present situation in India, roads are constructed with conventional methods, but not use ferrocement with artificial sand in concrete road. Hence we selected to work on this topic.

3. OBJCECTIVE 3

The study has the following objectives.

1. To compare the data of partially replace sand by artificial sand in ferrocement sample (1:3) with M40 grade (1:1.65:2.92) conventional concrete sample for road pavement.
2. To find out cost effective pavement or economically pavement.
3. To find out Time saving construction of pavement.
4. To suggest management plan for growth of road network in India.
5. The saving of a resource of natural sand by replacement of artificial sand.

4. RESULT 4

Table No.: 6 Compressive Strength of 150mm Cubes (average of 3 cubes) for conventional concrete (M40 grade) for 7days and 28 days.

Sr. No.	Sample	W/C ratio	7 days(Mpa)	Average (Mpa)	28 days(Mpa)	Average (Mpa)
1	C1	0.45	26.80	26.85	42.22	42.76
2	C2	0.45	27.20		42.75	
3	C3	0.45	26.57		43.33	

Table No.: 7 Compressive Strength of 150mm Cubes (average of 3 cube) for sand replaced artificial sand concrete (1:3 proportion) for 7days and 28 days.

Sr. No.	Sample	W/C ratio	7 days(Mpa)	Average (Mpa)	28 days(Mpa)	Average (Mpa)
1	S1	0.45	24.67	24.94	38.88	39.02
2	S2	0.45	25.97		39.55	
3	S3	0.45	24.2		38.63	

Table No.: 8 Flexural strength of 900x250x150mm panel (average of 2 panel) for conventional concrete (M40 grade) for 7days and 28 days.

Sr. No.	Sample	W/C ratio	7 days (Mpa)	Averag e (Mpa)	28 days (Mpa)	Average (Mpa)
1	Cp1	0.45	0.61	0.59	0.79	0.78
2	Cp2	0.45	0.57		0.78	

Table No.: 9 Flexural strength of 900x250x125mm panel (average of 2 panel) sand replaced artificial sand concrete (1:3 proportion) for 7days and 28 days.

Sr. No.	Sample	W/C ratio	7 days (Mpa)	Average (Mpa)	28 days(Mpa)	Average (Mpa)
1	Fp1	0.45	0.57	0.56	0.75	0.76
2	Fp2	0.45	0.55		0.77	

Table No.: 10 Flexural strength of 900x250x100mm panel (average of 2 panels) sand replaced artificial sand concrete (1:3 proportion) for 7days and 28 days.

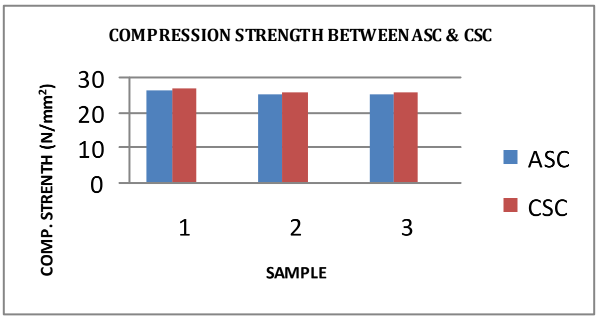
Sr. No.	Sample	W/C ratio	7 days (Mpa)	Average (Mpa)	28 days (Mpa)	Average (Mpa)
1	Fp1	0.45	0.44	0.45	0.59	0.60
2	Fp2	0.45	0.46		0.61	

Table No.: 11 Flexural strength of 900x250x75mm panel (average of 2 panel) sand replaced artificial sand concrete (1:3 proportion) for 7days and 28 days.

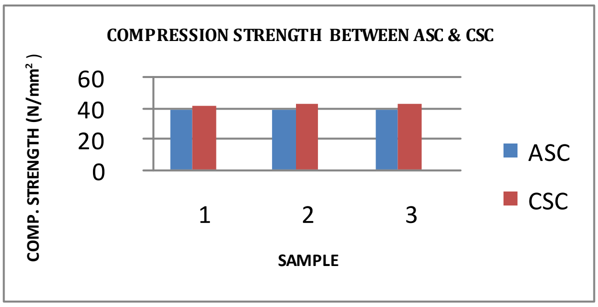
Sr. No.	Sample	W/C ratio	7 days(Mpa)	Average (Mpa)	28 days(Mpa)	Average (Mpa)
1	Fp1	0.45	0.35	0.35	0.47	0.48
2	Fp2	0.45	0.36		0.49	

5. GHRAPH 5

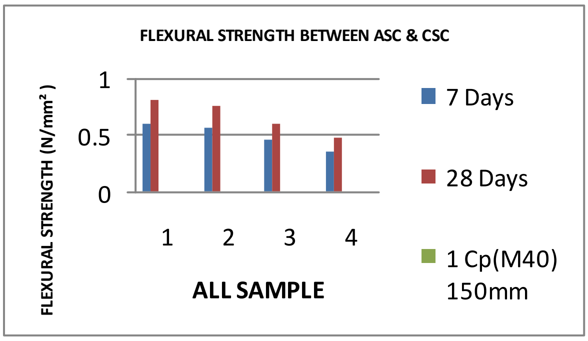
ASC: artificial sand concrete
CSC: conventional sand concrete



Graph No: 1 Compression Strength between ASC & CSC



Graph No: 2 Compression Strength between ASC & CSC



Graph No: 3 Flexural Strength between ASC & CSC

Table No.: 12 Cost of Analysis concrete (900x250x150mm)

Sr. No.	Material Required	Conventional Concrete (kg)	Rate	Total Cost (Rs)
1	Cement	14.54	5.8/kg	84.33
2	Sand	23.99	1/kg	23.99
3	Steel	2	37/m²	74
4	Aggregate	42.46	0.50kg	21.23
Grand Total				203.55/-

Table No.:13 Cost of artificial concrete (900x250x75mm)

Sr. No.	Material Required	Artificial Concrete (kg)	Rate	Total Cost (Rs)
1	Cement	9.28	5.8/kg	53.82
2	Sand	8.35	1/kg	8.35
3	Wire mesh	0.18 m²	110/m²	19.8
4	Artificial sand	19.49	0.55/kg	10.71
			Grand Total	92.68/-

Table No.:14 Cost of artificial concrete (900x250x125mm)

Sr. No.	Material Required	Artificial Concrete	Rate	Total Cost (Rs)
1	Cement	15.46 kg	5.8/kg	89.66
2	Sand	13.92 kg	1/kg	13.92
3	Wire mesh	0.18 m²	110/m²	19.8
4	Artificial sand	32.48 kg	0.55/kg	17.86
			Total	141.24/-

6. CONCLUSIONS

1) As per above test results we conclude that the 125mm thick roads is partially replace by reinforced concrete roads but fully replaced by cement concrete roads because in cement concrete roads, no steel are use therefore the strength of cement concrete roads are less compare to reinforced concrete roads.
2) As per above test results the 75mm thick roads gives strength about 0.35 for 7 days & 0.48 for 28 days due to this results we conclude that we will used 75 mm thick roads in college campus, play ground etc.
3) As per above test results the 100mm thick roads gives strength about 0.45 for 7 days & 0.60 for 28 days due to this results we conclude that we will used 100mm thick roads in village roads. Because low density of traffic and less live load.
4) The use of Artificial sand in the construction industry helps to prevent unnecessary damages to the environment and provide optimum exploitation of the resources.
5) Also it was seen that for water/cement ratio of 0.45 the results were promising.
6) Sand replaced ferrocement is economical as compared to conventional concrete.
7) Artificial sand is made by crushing aggregate to size appropriate for use as a fine aggregate. During the crushing process the artificial sand have irregular shapes and more fine particles contribution to improve compressive strength, compared to natural sand control mix.

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