TECHNO ECONOMICAL USE OF QUARTZITE ROCK DUST AND EFFECT OF GLASS FIBERS IN RIGID PAVEMENTS

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ABSTRACT- In this experimental study sand is replaced by quartzite rock dust from available sources. Quartzite rock dust replacement up to 40% by weight of cement in steps of 10% increments and 0.2% glass fibers by weight of cement was also included for further enhancing flexural strength of concrete. Thickness of pavement was evaluated with required parameters as per IRC-58:2002.From the results it was found that the pavement thickness can be reduced up to 19.04%.

Key Words: Quartzite rock dust, Glass fibers, Flexural strength, Pavement thickness

1. INTRODUCTION

In the recent past good attempts have been made for the successful utilization of various industrial by products (such as fly ash, silica fume, rice husk ash, foundry waste, slag, limestone powder) in concrete. In addition to this, an alternative source for the potential replacement of natural aggregates in concrete has gained good attention. As a result reasonable studies have been conducted to find the suitability of quartzite rock dust in conventional concrete to overcome the stress and demand for river fine aggregate and cement in construction of roads and other works.

2. LITERATURE

In previous investigations researchers used foundry sand, ceramic dust;,fly ash, hypo-sludge, waste plastic and quarry dust were used as alternative materials for sand. Past experimental studies have revealed that use of glass fibers significantly enhances flexural strength of concrete, which in turn reduces the thickness of pavement. Venkata Sairam Kumar,N.B.PandurangaRao,Krishna Sai.M.L.N;et al [1] have investigated on partial replacement of cement with quarry dust for studying mechanical properties of concrete. In this experimental work, the percentages of quarry dust used as a partial replacement of cement in concrete was 0, 10%, 15%, 20%, 25%, 30%, 35%, and 40% for M20, M30, M40 grade concrete. They have concluded from the experimental studies that 25% of partial replacement of cement with quarry dust improved hardened concrete properties**. Nagesh Tatoba Suryawanshi Samitinjay S Bansode Dr Pravin D Nemade et al [2]** have been carried out experiments on fly ash to replace some part of cement and sand to the extent of 10-30 percent and 5-15 percent respectively. Because of the use of fly ash, rigid pavement behaves as a semi rigid pavement causing substantial reduction in cost of construction. If the fly ash is utilized on large scale for road construction. **K Vamshi krishna1 J Venkateswara Rao et al [3]** have been studied the influence of glass fibers on the mechanical properties of the M20 grade concrete. Glass fibers of 0.1%, 0.2%, and 0.3% by weight of cement are added to the mix. It is found that 0.2% fibers by weight of cement is the optimum dosage. Using the flexural strength values at 0.2% fiber content, pavement thickness is evaluated as per IRC : 58, it is observed that there is a reduction in the pavement thickness by 25.8%.**K vamshi krishna1 J Venkateswara Rao et al [4]** have done experimental investigation on mechanical properties of M20 grade concrete by incorporating polyester fibers in the mix. Polyester fibers of 0.1%,0.2%,0.3%,0.4% by weight of cement are added to the mix. It is observed that 0.3% fibers by weight of cement is the optimum dosage. It is found that with 0.3% fiber content results in 20% reduction of pavement thickness. In this experimental study cement is replaced by quartzite rock dust up to40% and 0.2% Glass fibers by weight of cement were also included. Thickness of pavement is evaluated with parameters by IRC-58:2002.

3. MATERIALS & MIX DESIGN

3.1 Materials

Ordinary Portland cement (OPC) of grade 43 with a specific gravity of 3.12, quartzite rock dust is taken from locally available sources, aggregate with a maximum size of 20mm down size with a specific gravity of 2.78 was used. Various physical properties of coarse aggregates are given in Table.1.Locally available sand with a specific gravity of 2.71 was used as fine aggregate. The glass fibers of 6 mm length and diameter of 0.012mm are used in the present study. A water reducing admixture, rheo build 920kk is used in concrete. Its density and pH are 1.19 and >6 respectively.

Material property	Water absorption	Aggregate Impact	Aggregate Crushing	Flakiness Index	Elongation Index
Percentage by weight	0.5%	26%	29%	9%	12%

3.2Mix Design

Samples are prepared for M-40 grade. For the design of mix IS: 10262-2009 recommendations are adopted. Mix proportions of M-40 are given in the following table.1.

Material	Cement	Sand	Coarse aggregate	W/C Ratio	Admixture
Weight	440.52kg/m^3	563.5kg/m^3	1135kg/m^3	0.38	2.07it

Table 1.Mix Proportions

3.3 Specimens Preparation

In a mixer quartzite dust and cement are mixed thoroughly in required proportions until uniform color was achieved. Next, sand and coarse aggregates are added and mixed thoroughly again for 2 to 3 minutes. Glass fibers respective quantity of fibers are added and mixed for 1 to 2 minutes. The mix was then transferred in to cubes (150mm x 150mm x 150mm) and prisms (100mm x100mm x 500mm). During transferring the mix was compacted in three layers. Mix was then compacted on vibrator to expel the air.

3.4 Test Setup

The specimens were tested for 7 and 28 day compressive strength. The specimens were subjected to a compressive force at the rate of 5 KN/sec until they failure occurs. The mean value of the compressive strengths of three test cubes in a series is reported as compressive strength of a particular mix. For finding the flexural strength of prisms IS: 516-1959 guide lines are followed.

Fig4.1.Cube Testing Fig 4.2.Prisims Testing

4. RESULTS AND DISCUSSIONS

4.1 Compressive Strength Test

Compressive strength values of cube specimens were at 7&28 days testing given in below graph. From the figure 4.3 it was observed that rate of increment in compressive strength of the Quartzite rock dust concrete is 9.04% and 8.94% at age of 7&28 days respectively compared to conventional concrete. From the graph it was clear that there is an improvement in compressive strength of the Quartzite rock dust with glass fibers is 14.59% and 14.67% at age of 7&28 days respectively compared to quartzite rock dust concrete. It is evident that from results compressive strength of Quartzite rock dust concrete with glass fiber increases to 24.95% and 24.93% at age of 7&28 days respectively compared to Quartzite rock dust concrete.

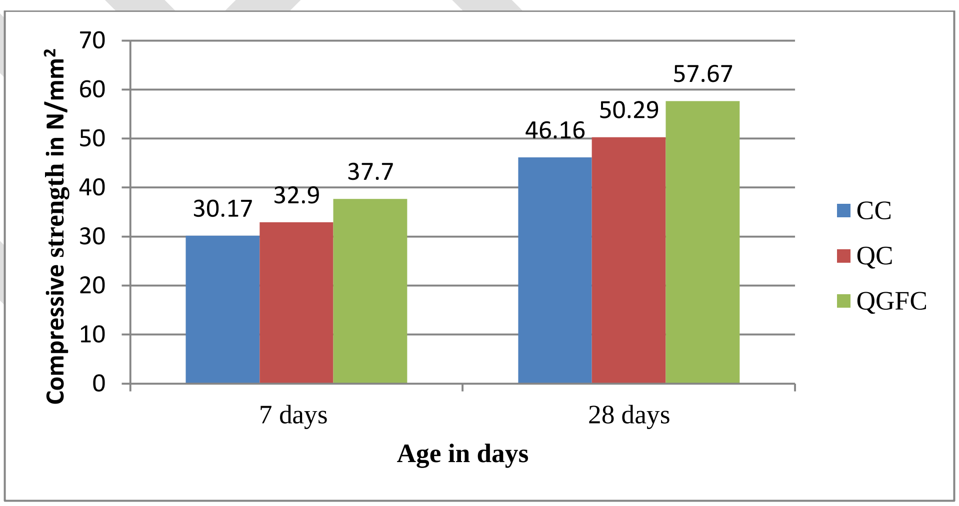

Fig 4.3 Compressive strength of CC,QC & QGFC at 7&28 days

4.2 Flexural Strength Test

Flexural strength of beam specimens are tested on UTM at 7&28 days .results are given below

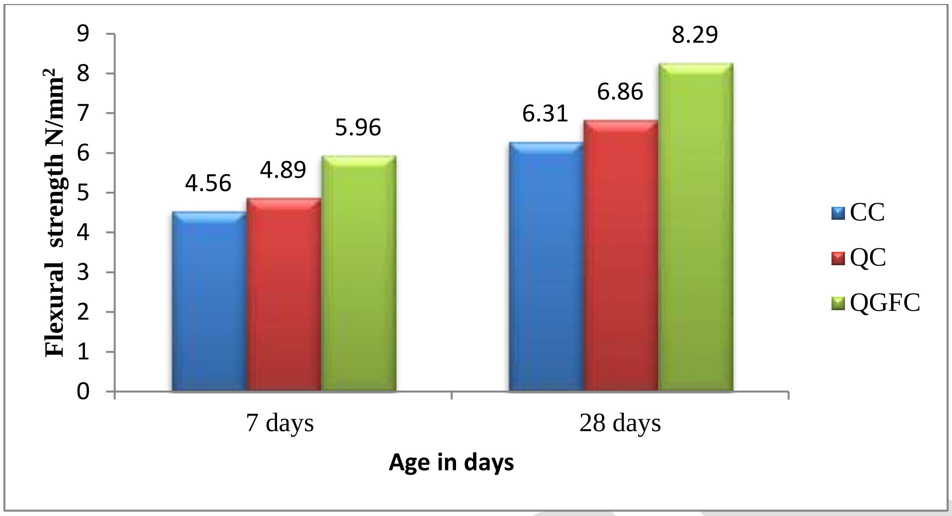

Fig 4.4 Flexural strength values of different mixes at 7&28 days

From the figure 4.4 it was observed that rate of increment in flexural strength of the Quartzite rock dust concrete is 7.23% and 8.71% at age of 7&28 days respectively compared to conventional concrete. From the graph it was clear that there was an improvement in flexural strength of the Quartzite rock dust with glass fibers was 21.88% and 20.84% at age of 7&28 days respectively compared to quartzite rock dust concrete. It was evident that from results flexural strength of Quartzite rock dust concrete with glass fiber increases to 30.7% and 31.38% at age of 7&28 days respectively compared to Conventional concrete.

5. PAVEMENT SLAB DESIGN AND ANALYSIS

Pavement slab was designed as per IRC 58:2002. The flexural strength is directly taken from the beam flexural test. The axial load spectrum is taken from IRC: 58-2002 and other data used in this design are given below. A cement concrete pavement was to be designed for a two lane two-way National Highway. The total two-way traffic is 7842 commercial vehicles per day at the end of the construction period.

The design parameters are

Effective modulus of subgrade reaction of the DLC sub-base	=	8 kg/cm^3
Elastic modulus of concrete	=	$3\times10^5 kg/cm^2$
Poisson’s ratio	=	0.15
Coefficient of thermal expansion of concrete	=	$10\times10^{-6}/^0C$
Tyre pressure	=	8 kg/cm^2
Rate of traffic increase	=	0.075
Spacing of contrction joints	=	4.5 m
Width of slab	=	3.5 m
Design life	=	30 years
Present traffic	=	7842 cvpd

Single Axles		Tandem Axles	
Load in tones	Expected repetitions	Load in tones	Expected repetitions
20	644496	36	322248
18	1353442	32	193348
16	3158032	28	580046
14	7218361	24	1417892
12	10183045	20	7282810
10	10311945	16	94909649
Less than 10	14178924	Less than 16	4640375

Table 2 Expected repetitions for single and tandem axles

Taking the above design parameters and expected repetition values into considerations and design the slab thickness according to IRC-58:2002 for conventional, quartzite with and without glass fiber concretes.

Grade of concrete(M_{40})	Flexural strength (Kg/cm^{2})	Slab thickness (cm)	Fatigue life consumed	Corner stress (Kg/cm^{2})
CC	61.9	25	0.56	23.8
QC	71.9	24	0.52	26.95
QGFC	88.04	21	0.43	32.65

Table 3 Slab thickness design

6. Cost Comparison of Pavements

A cement concrete pavement was to be laid with 25cm,24cm and 21cm thick slabs for CC,QC and QGFC respectively . Quantity and cost of each material for that stretch is calculated and compared for conventional concrete and quartzite dust with and without glass fiber concrete in this section. In this analysis cost was estimated for 1m length and 3.5m width of pavement.

S.no.	Material	Rate per kg in Rs.
1	Cement	6.11
2	Fine aggregate	0.46
3	Coarse aggregate (20mm)	0.88
4	Coarse aggregate (10mm)	0.63
5	Super plasticizer	60
6	Fibers(glass)	150
7	Quartzite rock dust	0.13

Table 4 Cost of each material

Pavement type	Thickness (cm)	Cost (rupees)
CC	25	3714.46
QC	24	2852.74
QGFC	212	2576.50

Table 5 Cost analysis of CC,QC&QGFC pavements

From the above results we can save 1137.96 /- Rs per 1m length by using combination of glass fiber and quartzite dust. The construction cost of the pavement was reduced by 44.17% by using combination of glass fiber and quartzite rock dust.

7. CONCLUSIONS

1. Optimum dosage of replacement of cement by quartzite rock dust was 30%.
2. Rate of increment in flexural strength of the Quartzite rock dust concrete is 8.71% at age of 28 days compared to conventional concrete.
3. About 20.84% of increment in flexural strength was found by using quartzite rock dust with glass fibers at age of 28 days compared to quartzite rock dust concrete.
4. Glass fibers addition to quartzite rock dust concrete enhances its compressive strength by 31.38%.
5. Thickness of pavement is reduced up to 19.04% by replacement of cement with quartzite rock dust and addition of glass fibers in concrete.
6. Construction cost of the pavement is reduced up to 44.17%, by partial replacement of cement with quartzite rock dust and inclusion of glass fibers in concrete.

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