IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 13, Issue 6 Ver. V (Nov. - Dec. 2016), PP 78-84
www.iosrjournals.org

Influence of Quartzite as a Partial Replacement of Coarse Aggregate in Rigid Pavement (Both in Normal Water and Sea Water Conditions)

Simma Ravi Kiran, P.Hanitha
P.G Scholar, Department of Civil Engineering, Sankentika Institute of Technology and Management, Visakhapatnam, A.P., India.
Asst. Professor, Department of Civil Engineering, Sankentika Institute of Technology and Management, Visakhapatnam, A.P., India.

Abstract: *Concrete is most commonly and widely used material in infrastructure development. Coarse aggregate is major ingredient of concrete which constitutes to about 60 to 70% in terms of volume of concrete. The cost of coarse aggregate is increasing day by day due to its limited availability and large demand. In the present work, Quartzite is used as an alternate material to coarse aggregate and studies various engineering and mechanical properties. Experimental studies were performed on plain cement concrete by replacing coarse aggregate up to 100% and durability studies were performed by 100% replacement of coarse aggregate. The mix design and test methods are followed in accordance with the Bureau of Indian Standards. The concrete made with quartzite performed well in terms of compressive strength and showed higher performance for 7, 28 and 90 days than conventional concrete. The compressive strength of concrete made with quartzite is less than the strength of conventional concrete in normal water curing, but the reduction in strength is very nominal. The concrete made with quartzite performed well in terms of compressive strength and showed higher performance for 7, 28, and 90 days than conventional concrete when exposed to sea water, and temperature effect and showed satisfactory performance. Overall, the performance of quartzite is reasonably good when exposed to various weathering conditions and the same can be replaced as coarse aggregate in concrete.*

Keywords: *Quartzite, concrete, coarse aggregate, Compressive Strength, Flexural Strength, Splint Tension Strength.*

I. Introduction

Concrete has a great advantage in which there is a possibility to choose its constituents and then it is up to the user to exploit and optimize the unique properties of each of the components to develop a high quality, durable construction material of high impermeability.The coarse aggregate is generally coarse gravel or crushed rocks such as lime stone or granite, along with a fine aggregate such as sand. The cement commonly Portland cement and other cementitious materials such as fly ash and slag cement serve as a binder for the aggregate. Various chemical admixtures are also added to achieve varied properties. Water is then mixed with this dry composite which enables it to be shaped (typically poured) and then solidified and hardened into rock-hard strength through a chemical process called hydration.The demand for aggregates will increase heavily. Already there was problem for the availability of good quality aggregate in which there was restriction for mining by environmental laws. This situation leads to longer distance to transport which will add to energy costs. In Kerala state there are importing aggregate from as far away as from Gujarat or even from Vietnam in which there is an urgent need to look alternative materials like light weight aggregates to overcome this problem. Since aggregates in concrete comprise about 80% of the total volume of concrete any reduction in natural aggregates consumption will have significant impacts in the environment. Quartzite being used in the present study obtained as the byproduct of the processing industry was utilized as coarse aggregate replacement.

Quartzite is commonly used as refractory material and as a flux in iron and steel industry. The chemical composition of the quartzite comprises 95-98% of silicon dioxide, 0.4-4 % aluminum dioxide and 0.2-1.5% ferrous oxide. It is estimated that 3000 tonnes of insitu reserve of quartzite is in available in Andhra Pradesh, India out of which 2000 tonnes is considered recoverable. The major deposits are available in Vizianagaram district of Andhra Pradesh from which the material was obtained for the current study.

To study the compatibility of quartzite as alternate material as coarse aggregate in concrete**.** To determine the performance of Compression Strength, Flexural Strength and Split Tensile Strength by a Quartzite concrete with different percentage. To study the effect of quartzite concrete and convention concrete both in normal water and sea water.To study the effect of temperature on the quartzite concrete

Almesfer had replaced coarse aggregate with Waste Glass in which he had observed that the compressive strength trend at 28 days with the addition of Waste Glass significantly decreasing the compressive strength for all concrete mixes. This decrease in compressive strength is due to the high brittleness of glass leading to cracks which result in incomplete adhesion between the WG and cement paste, while the poor geometry and reduced specific gravity of glass leads to a heterogeneous distribution of aggregates.
Medina said that coarse sanitary ware aggregates has higher water absorption than coarse natural aggregates. The results reported, respectively 0.6% and 0.2%, showed that these properties are very similar for recycled and natural aggregates. They stated that the bulk density is higher for coarse natural aggregates (2630 kg/m3) than for coarse recycled ceramic aggregates (2390 kg/m3).

II. Material Properties

A. Material test results

I. Cement

- Specific gravity of cement = 3.1
- Fineness modulus of cement = 7%
- The percentage of water required to produce cement paste of standard consistency 29%
- The initial setting time of the cement used is 57 minutes. > 30 minutes (As per IS 4031- part5-1988 code).
- The final setting time of cement is 4hours 49minutes< 10 hours (As per IS 4031-part5-1988 code).

II. Fine aggregate

- ✓ Specific gravity of sand 2.59
- ✓ Fineness modulus of fine aggregate 2.38%
- ✓ Water Absorption for Fine aggregate 0.56%

III. Coarse aggregate

- Specific gravity of coarse aggregate 2.9
- Fineness modulus of coarse aggregate 7.87%
- Percentage voids in Coarse aggregate 48.72%
- Water Absorption for Coarse aggregate 0.77%
- Coarse aggregate crushing value 24.77%
- Coarse aggregate impact value 26.52%
- Abrasion value for Coarse aggregate 24.72%

IV Quartzite

Figure 1 Quartzite

- Specific gravity of Quartzite 2.68
- Fineness modulus of quartzite 7.04%
- Percentage voids in Quartzite 37.37%
- Water Absorption for Quartzite 0.49%
- Quartzite Crushing value 32.89%
- Quartzite impact value 34.14%
- Abrasion value for Quartzite 21.44%

B. Mix design

Grade designation: M30
Type of cement: OPC 53 grade (KCP Cement)
conforming IS: 12269
Maximum nominal size of aggregate: 20mm
Maximum water-cement ratio: 0.45

III. Experimental Tests

Hardened Concrete Tests

I. Compression strength:

Concrete curing was carried out with specimens of size 15 × 15 × 15 cm immersed in water. Compression strength of normal concrete and quartzite concrete with different percentage levels was carried according to Indian code IS 519:1959 with loading rate of 5.3 Kilo Newton per second and the results are presented in table for 7 and 28 days.

f_c= Failure load/ Cross sectional ar

Figure 2 Compression testing machine

II . Split tensile strength :

The resistance of a material to a force tending to tear it apart, measured as the maximum tension the material can withstand without tearing. Tested by keeping the cylindrical specimen in the compressive testing machine and is continued until failure of the specimen occurs.

f_{ct} =2P/ ld

Figure 3 Testing of Cylindrical Specimen

III. Flexural Strength:

The flexural strength may be expressed as the modulus of rupture f_b, which, if "a" equals the distance between the line of fracture and the nearer support, measured on the centre line of tensile side of the specimen, shall be calculated to the nearest 0.5kg/sq.cm as follows.

f_b =Pl/bd^2

Figure 4 Testing of Prism Specimen

Durability Tests

1. Sea water : In this study, the concrete performance in sea water was determined by immersion of concrete cubes in sea water under laboratory conditions. The specimens were removed from sea water after 28, 60, 90, 120 days, and then, the compressive strength and mass losses of the specimens were determined.
2. II. Temperature : In order to evaluate the behavior of different materials (natural aggregate and quartzite) with respect to the temperature applied, in this research work the specimens were heated in an electric furnace to 250^{o}c.The heating rate was set at 5^{o}c per minute. The respective maximum temperature was maintained for 1 hour. After that, the specimens were allowed to cool naturally to room temperature, by turning off the furnace and allowing for natural cooling.

Preparation of test results

I. Compressive strength

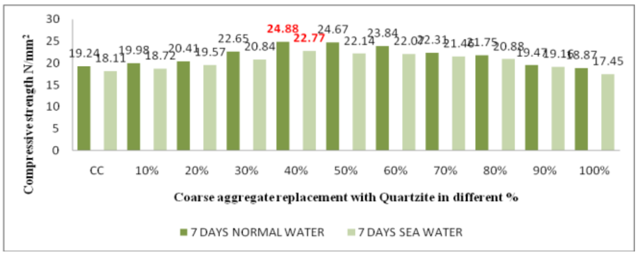

Figure 5 Compressive Strength of Cube specimen at 7 days in normal and sea water

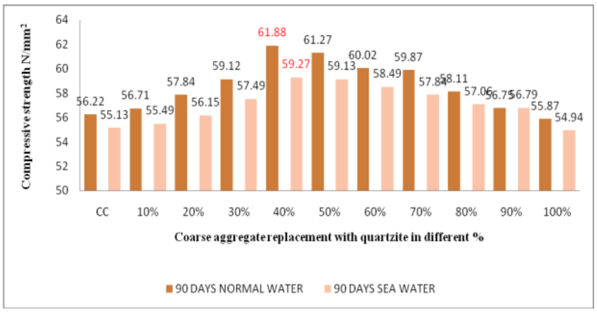

Figure 6 Compressive Strength of Cube specimen at 90 days in normal and sea water

II . Split tensile strength

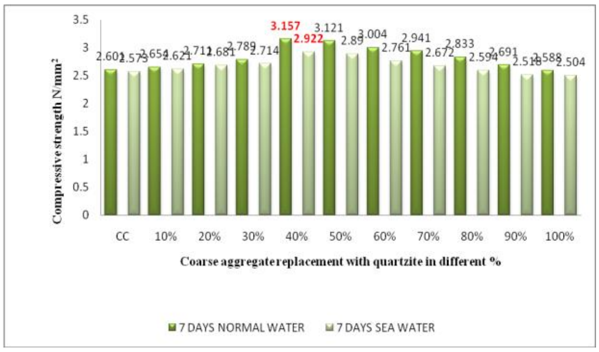

Figure 7 Split Strength of Cube specimen at 7 days in normal and sea water

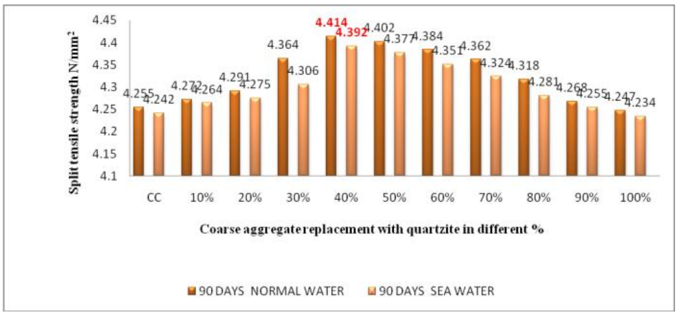

Figure 8 Split Strength of Cube specimen at 90 days in normal and sea water

III. Flexural Strength

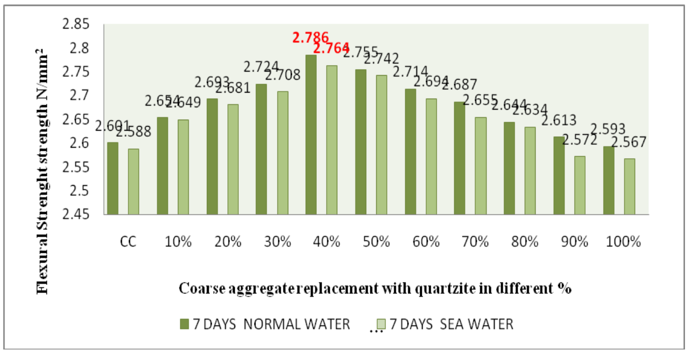

Figure 9 Flexural Strength of Cube specimen at 7 days in normal and sea water

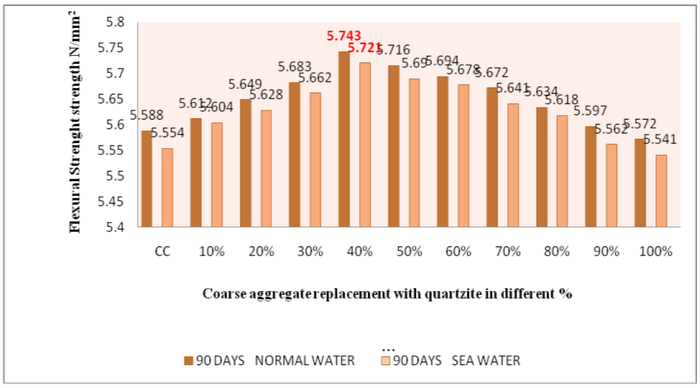

Figure 10 Flexural Strength of Cube specimen at 90 days in normal and sea water

IV Temperature

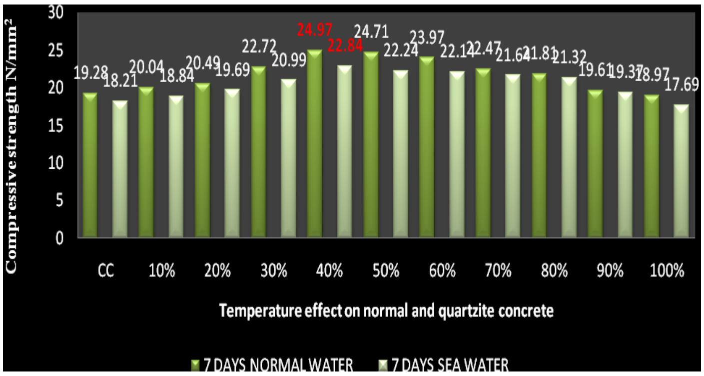

Figure 11 Temperature Effect of Cube Specimen at 7 days in normal and sea water

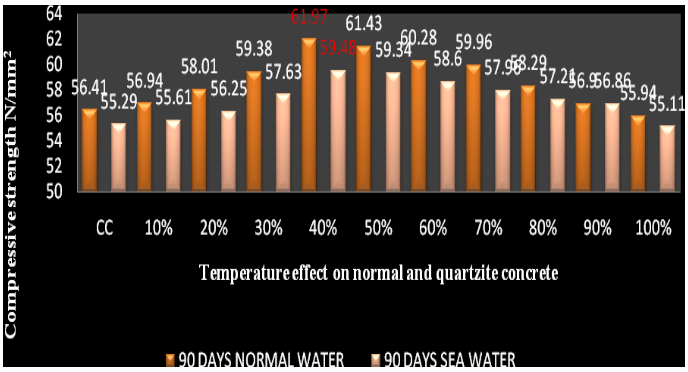

Figure 12 Temperature Effect of Cube Specimen at 90 days in normal and sea water

IV. Conclusion

- It is observed that the compressive strength of the concrete increases to 2.25%, 10.68%, 18.05%, and 29.61% when % of quartzite increases from 10%,20%,30% and 40% when it is compared with conventional concrete in normal water at 28 days. But the replacement is done till 100% replacement.
- It is observed that the compressive strength of the concrete increases to 4.28%, 12.75%, 18.65%, and 25.66% when % of quartzite increases from 10%,20%,30% and 40% when it is compared with conventional concrete in sea water at 28 days. But the replacement is done till 100% replacement.
- It is observed that the compressive strength of the concrete increases to 0.87%, 2.88%, 5.15%, and 10.06% when % of quartzite increases from 10%,20%,30% and 40% when it is compared with conventional concrete in normal water at 90 days. But the replacement is done till 100% replacement.
- It is observed that the compressive strength of the concrete increases to 0.65%, 1.85%, 4.28%, and 7.5% when % of quartzite increases from 10%,20%,30% and 40% when it is compared with conventional concrete in sea water at 90 days. But the replacement is done till 100% replacement.
- It is observed that the split tensile strength of the concrete increases to 1.65%, 3.33%, 7.76%, and 15.52% when % of quartzite increases from 10%,20%,30% and 40% when it is compared with conventional concrete in normal water at 28 days. But the replacement is done till 100% replacement.
- It is observed that the split tensile strength of the concrete increases to 0.82%, 2.75%, 3.86%, and 13.8% when % of quartzite increases from 10%,20%,30% and 40% when it is compared with conventional concrete in sea water at 28 days. But the replacement is done till 100% replacement.
- It is observed that the split tensile strength of the concrete increases to 0.39%, 0.84%, 2.56%, and 3.73% when % of quartzite increases from 10%,20%,30% and 40% when it is compared with conventional concrete in normal water at 90 days. But the replacement is done till 100% replacement.
- It is observed that the split tensile strength of the concrete increases to 0.51%, 0.77%, 1.5%, and 3.53% when % of quartzite increases from 10%,20%,30% and 40% when it is compared with conventional concrete in sea water at 90 days. But the replacement is done till 100% replacement.
- It is observed that the Flexural strength of the concrete increases to 0.79%, 2.21%, 3.22%, and 5.12% when % of quartzite increases from 10%,20%,30% and 40% when it is compared with conventional concrete in normal. water at 28 days. But the replacement is done till 100% replacement.
- It is observed that the Flexural strength of the concrete increases to 1.01%, 2.17%, 3.19%, and 4.88% when % of quartzite increases from 10%,20%,30% and 40% when it is compared with conventional concrete in sea water at 28 days. But the replacement is done till 100% replacement.
- It is observed that the Flexural strength of the concrete increases to 0.42%, 1.09%, 1.7%, and 2.7% when % of quartzite increases from 10%,20%,30% and 40% when it is compared with conventional concrete in normal. water at 90 days. But the replacement is done till 100% replacement.
- It is observed that the Flexural strength of the concrete increases to 0.9%, 1.33%, 1.94%, and 3.0% when % of quartzite increases from 10%,20%,30% and 40% when it is compared with conventional concrete in sea water at 90 days. But the replacement is done till 100% replacement.
- It is observed that the temperature effect of the concrete increases to 2.35%, 10.96%, 18.7%, and 29.8% when % of quartzite increases from 10%,20%,30% and 40% when it is compared with conventional concrete in normal water at 28 days. But the replacement is done till 100% replacement.
- It is observed that the temperature effect of the concrete increases to 4.14%, 12.72%, 18.57%, and 25.3% when % of quartzite increases from 10%,20%,30% and 40% when it is compared with conventional concrete in sea water at 28 days. But the replacement is done till 100% replacement.
- It is observed that the temperature effect of the concrete increases to 0.93%, 2.83%, 5.26%, and 9.85% when % of quartzite increases from 10%,20%,30% and 40% when it is compared with conventional concrete in normal water at 90 days. But the replacement is done till 100% replacement.
- It is observed that the temperature effect of the concrete increases to 0.57%, 1.73%, 4.23%, and 7.57% when % of quartzite increases from 10%,20%,30% and 40% when it is compared with conventional concrete in sea water at 90 days. But the replacement is done till 100% replacement.

References

[1]. Akbulut H, Gürer C. "Use of aggregates produced from marble quarry waste in asphalt pavements". Build Environ (2007) 42: 1921–30.
[2]. J.R. Correia , J.S. Lima, J. de Brito "Post-fire mechanical performance of concrete made with selected plastic waste aggregates", Cement & Concrete Composites 53 (2014) 187–199.
[3]. Debieb F, Kenai S. "The use of coarse and fine crushed bricks as aggregate in concrete". Constr Build Mater (2008) 22(5):886–93.
[4]. De Brito J, Pereira AS, Correia JR. "Mechanical behaviour of non-structural concrete made with recycled ceramic aggregates". Cem Concr Compos (2005) 27(4):429–33.
[5]. Hanifi Binici "Durability of heavy weight concrete containing barite", Int.J.Mat.Res.101 (2010) 8.
[6]. Hanifi Binici , Tahir Shah, Orhan Aksogan, Hasan Kaplan "Durability of concrete made with granite and marble as recycle aggregates", journal of materials processing technology 2 0 8 (2 0 0 8) 299–308.

[7]. Hanifi Binici a, Orhan Aksogan b, Ela Bahsude Gorura, Hasan Kaplan c, Mehmet Nuri Bodur d "Performance of ground blast furnace slag and ground basaltic pumice concrete against seawater attack", Construction and Building Materials 22 (2008) 1515–1526.

[8]. Henki Wibowo Ashadi, Boy Ahmad Aprilando, Sotya Astutiningsih "Effects of steel slag substitution in geopolymer concrete on compressive strength and corrosion rate of steel reinforcement in seawater and an acid rain environment", International Journal of Technology (2015) 2: 227-235.

[9]. Jose kurian (2013) ICI-IWC "Developments In Concrete Industry Indian Scenario", October 23 rd 2013.

[10]. [10] Khatib JM. "Properties of concrete incorporating fine recycled aggregate", Cement Concrete Res (2005) 35(4):763–9.

[11]. [11] Medina C, Rojas MIS, Frías M. "Reuse of sanitary ceramic wastes as coarse aggregate in eco-efficient concretes". Cem Concr Compos (2012) 34(1):48–54.

[12]. Mansur MA, Wee TH, Cheran LS. "Crushed bricks as coarse aggregate for concrete". ACI Mater J (1999) 96(4):478–84.

[13]. K. Muthusamy, G. Vesuvapateran and N.W. Kamaruzaman "Acid Resistance of Concrete Containing Laterite Aggregate as Partial Coarse Aggregate Replacement", Research Journal of Applied Sciences, Engineering and Technology (2014) 7(19): 3983-3985.

[14]. Neville, MA: Propriétés Des Bétons. Edition Eyrolles, Paris (2000).

[15]. Ivanka Netinger , Damir Varevac , Dubravka Bjegović , Dragan Morić "Effect of high temperature on properties of steel slag aggregate concrete", Fire SafetyJournal 59 (2013) 1–7.

[16]. Nasser Almesfer1 and Jason Ingham2 "Effect of Waste Glass on the Properties of Concrete" J. Mater. Civ. Eng. (2014) 26.

[17]. E.A. Olanipekun, K.O. Olusola, O. Ata "A comparative study of concrete properties using coconut shell and palm kernel shell as coarse aggregates" Building and Environment 41 (2006) 297–301.

[18]. Paulo B. Cachim "Mechanical properties of brick aggregate concrete" Construction and Building Materials 23 (2009) 1292–1297.

[19]. S. Platiasa, K. I. Vatalisa, G. Charalampidesa "Suitability of quartz sands for different industrial applications", Procedia Economics and Finance 14 (2014) 491 – 498.

[20]. Raman. P. K., Mineral resources of Andhra Pradesh. 1999. Geological Society of India, Bangalore.

[21]. M. A. Rashida, T. Hossaina, and M. A. Islam, "Properties of higher strength concrete made with crushed brick as coarse aggregate," Journal of Civil Engineering (IEB) (2009) vol. 37, no. 1, pp. 43-52.