STATE OF THE ART REVIEW ON UTILIZATION OF QUARRY WASTE REPLACEING FINE AGGREGATE IN CONCRETE

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Abstract

Concrete is most widely used material in construction industries and day by day the usage of fine aggregate in concrete has become challenge due to environmental problems. In this paper an attempt is made to reveal the facts and figure to utilize the quarry waste materials in concrete replacing fine aggregates. The quarry waste has very similar physical and chemical properties as river sand and they can be good substitute to natural river sand as fine aggregates. The quantity of waste produced is also very large to suffice the need of the construction industry for its potential use in concrete. The literature review reveals that quarry waste alone is used for its potential use in concrete. In this study detailed review is carried out for various doses for maximum strength and economy is carried out in various sections. After critical review it was found that there is very little work on durability aspects of concrete prepared by quarry waste in combination with other wastes.

Keywords: *Waste utilization, improved concrete, Sand replacement, Quarry waste*

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1. INTRODUCTION

Due to the recent spurt in construction activity brought on by the current economic boom, the cost of construction has been increasing by up to 15% every year, a major factor for this escalation in costs is the price of raw materials like cement, steel, timber, aggregates etc. Increasing extraction of natural sand from river beds causing many problems, loosing water retaining sand strata, deepening of the river courses, causing bank slides, loss of vegetation on the bank of rivers, exposing the intake well of water supply schemes, disturbs the aquatic life as well as affecting agriculture due to lowering the underground water table etc are few examples. Now a day the natural sand can decrease the quantity and the river bed is nearly finished. It is Loss of Environment. The various state governments has ban on sand excavation. It is a big problem of construction Industry. Now days the quarry waste is used in mortar, precast jellies and finishing of road pavement. The researchers are research on fine replacement of sand with Quarry waste. In India Annual production of quarry waste is 20 MT (CPCB Data). The quarry waste production in Gujarat is 0.2 MT (CPCB Data).

1.1 Quarry Waste Production & Properties

About 20 to 25 per cent of the total production in each crusher unit is left out as the waste material-quarry waste. It is in the form of powder. The size of quarry waste is below than 90 micron. The quarry waste is dependent on location. The figure 1 showing Image of quarry waste produced at crushing unit.

Fig 1.1 Crushing Unit producing quarry waste (A. A. Masrur Ahmed, 2010)

Table 1.1 Physical Properties of quarry waste

Sr. No	Properties	Quarry waste
1	Specific gravity	2.54
2	Bulk density Kg/m^3	1735
3	Water Absorption %	1.20
4	Moisture content %	Nil
5	Sieve analysis	FM= 2.5, Zone 2

Table 1.2 Chemical properties of quarry waste

Sr. No	Chemical Composition	Percentage
1	Silica	62.80
2	Aluminum dioxide	18.72
3	Ferric Oxide	6.54
4	Magnesium dioxide	2.56
5	Calcium dioxide	4.83
6	Sodium oxide	Nil
7	Potassium oxide	3.18

8	Titanium oxide	1.21
9	Loss of Ignition	0.48

1.1.1 Physical and Chemical Properties of Quarry Waste

The Physical properties of quarry waste are shown below. The table 1.1 shows the Physical properties of quarry waste.

1.2 Review of Quarry Waste replacing Fine Aggregate

V Bhikshma R, R Kishore and N H M Raju [1] used 0%, 25%, 50%, 75% and 100% replacement of sand with quarry waste. The 25% replacement of sand with quarry waste increase 3% in compressive strength at 28 days. The 50% replacement of sand with quarry waste increase 10% in compressive strength at 28 days. The 75% replacement of sand with quarry waste increase 17% in compressive strength at 28 days. The 100% replacement of sand with quarry waste increase 22% in compressive strength at 28 days.

V Syam Prakash, Dhanya Krishna N and G Jeenu [2] used 20%, 40%, 60% and 80% replacement of sand with quarry waste. The 28 days compressive strength of Mix_{220} decreases 20.28% from 28 days compressive strength of Mix 200. The 28 days compressive strength of Mix_{240} decreases 17.35% than 28 days compressive strength of Mix_{200}. The 28 days split tensile strength of Mix_{160} increases 0.90% than 28 days split tensile strength of Mix_{100}. The 28 days split tensile strength of Mix_{260} decreases 3.41% from 28 days compressive strength of Mix_{200}.

Sudhir S Kapgate and S R Satone [3] used 0%, 20%, 25%, 30%, 35% replacement of sand with quarry waste. The 35% replacement of sand with quarry waste in M25 grade concrete increases 1.38% in compressive strength at 28 days. The 35% replacement of sand with quarry waste in M25 concrete increases 30.48% in split tensile strength at 7 days. The 35% replacement of sand with quarry waste in M25 grade of concrete decreases 18% in split tensile strength at 14 days. The 35% replacement of sand with quarry waste in M25 concrete decreases 20.37% in split tensile strength at 28 days.

Dr P B Sakthivel, C Ramya and M raja [9] used 0%, 10%, 20%, 30%, 40% replacement of sand with quarry waste. The Author has made S_{90} D_{10}, S_{80} D_{20}, S_{70} D_{30} and S_{60} D_{40} for compressive strength, split tensile strength and flexure strength. The 10% replacement of sand with quarry waste 10% improved compressive strength at 28 days. The 20% replacement of sand with quarry waste decreases 22.4% compressive strength at 28 days. The 10% replacement of sand with quarry waste is increases 23% compressive strength at 28 days. The 20% replacement of sand with quarry waste increases 19% split tensile strength at 28 days. The 10% replacement sand with quarry waste increases 12% flexure strength at 28 days. The 20% replacement of sand with quarry waste improved 6% flexure strength at 28 days.

Table 1.3 Review of quarry waste replacing fine aggregate

Author	Per replace	Significant contribution
V Bhikshma	0%-100%	At 30% replacement of sand with Quarry Waste improved by 10% compressive strength
V Syam Prakash	0%-80%	At 20% replacement of sand with quarry Waste improved 3.85% compressive strength
Sudhir S Kapgate	0%-35%	At 30% replacement of sand with quarry waste improved 6.94% compressive strength
Dr P B Sakthivel	0%-40%	At 20% replacement of sand with quarry waste decrease 20% compressive strength
Radhikesh P Nanda	0%-100%	At 25% replacement of sand quarry waste gives similar compressive strength
G balamurgan	0%-100%	At 20% replacement of sand with quarry waste improved 8% compressive strength
Lohani T K	0%-50%	At 30% replacement of sand with quarry waste improved 5% compressive strength
R. Ilangovana	0%-100%	At 100% replacement sand with quarry waste improved 10% compressive strength

Radhikesh P Nanda, Amiya K Das, Moharana N C has [12] used 0%, 25%, 50%, 75%, 100% replacement of sand with quarry waste. The 28 days compressive strength of normal concrete is 35 N/mm^2. The FC_{25} 28 day's compressive strength is similar to the normal concrete. The FC_{50} 28 day's compressive strength decreases 3% than FC_0. The 28 days Flexure strength of FC_0 is 8.40 N/mm^2. The FC_{25} 28 days Flexure strength is 8.01 N/mm^2. The FC_{50} 28 days Flexure strength is 7.95 N/mm^2. The FC_{25} flexure strength decreases 4.76% at 28 days. The FC_{50} flexure strength decreases 2.85% at 28 days.

G balamurgan and Dr P Perumal [10] used 0% to 100% replacement of sand with quarry waste. The 0% replaced concrete gives 22.22 N/mm^2 at 28 days. The 28 days compressive strength decreases 2.02% at 28 days. The 28 days compressive strength of 20% replaced concrete improved 8.01%. The 28 days compressive strength at 30% replaces improved 13.99%. The 28 days 10% compressive strength improved 0.53% at 100˚C. The 28 days compressive strength of 20% replaced concrete improved 3.61 % at 100˚C. The 28 days compressive strength of 30% replaced concrete improved 4.18% at 100˚C.

Lohani T K, Padhi M and Dash K P [6] used 0%, 20%, 30%, 40%, 50% replacement of Sand with Quarry waste. The 30% replacement of sand with quarry waste gives 0.845% compaction factor. The 30% replacement of sand with quarry waste increases 17.39% in compressive strength at 7 days. The 30% replacement of sand with quarry waste

increases 11.47% in compressive strength at 28 days. The 30% replacement of sand with quarry waste increases 11.76% in compressive strength at 91 days. In this study 30% replacement of sand with Quarry waste improved 5% compressive strength.

R. Ilangovana, N. Mahendrana and K. Nagamanib [11] used 0% and 100% replacement of sand with quarry waste. The M20 grade concrete gives 31 N/mm^2. The 28 days compressive strength of quarry waste improved 11.26%. The 100% quarry waste improved 11.36% in M30 grade concrete. The 100% quarry waste improved 3.63% compressive strength in M40 grade concrete at 28 days. The M20 grade concrete gives 5.10 N/mm^2. The 100% quarry waste in M20 improved 25.49% in Flexure strength at 28 days. The 100% quarry waste M30 in improved 9.72% at 28 days. The 100% quarry waste in M40 improved 10.22 % in flexure strength at 28 days.

1.3 Review of Quarry Waste replacing Fine Aggregate in Mortar/Masonry

Mohaiminal Haque, Sourav Ray and H M A Mahzuz [5] used 0%, 30%, 70% and 100% replacement of sand with quarry waste. The 7 days compressive strength of 30% replacement of sand with quarry waste in mortar increases 1.79% from normal concrete. The 14 days compressive strength of 30% replacement of sand with quarry waste is increases 1.96% from normal concrete. The 28 days compressive strength of 30% replacement of sand with quarry waste is increases 5.50% from normal concrete. The 28 days cylinder compressive strength for 25% replacement of sand with quarry waste decreases 11.97% from normal mixture. In this study 30% replacement of sand with quarry waste improved 5.50% compressive strength.

Table 1.4 Review of sand replacement with quarry waste in mortar/masonry

Author	Per replace	Significant contribution
Mohaiminal Haque	0%-100%	At 30% replacement of sand with Quarry Waste improved 5.50% compressive strength
S P S Rajput	0%-100%	At 100% Replacement of Sand With Quarry Waste Increase 70% Brick Masonry Compressive Strength

S P S Rajput and M S Chauhan [8] used zero and full replacement of sand with quarry waste. The mortar cubes of 100% replacement of sand with quarry waste increase 54% compressive strength at 3 days. The mortar cubes of 100% replacement of sand with quarry waste increase 30% compressive strength at 7 days. The brick masonry wall of 105mm*225mm*445mm dimension using 100% replacement of sand with quarry waste increase 30% compressive strength. In this study 100% Replacement of Sand with quarry waste is increase 70% brick masonry compressive strength.

1.4 Various Authors have Research on Replacement of Sand with Quarry Waste and Cement Replace with GGBS in Concrete

Venu Malagavelli and P N Rao [4] used 0%, 5%, 10%, 15%, 20%, 25% and 30% replacement of sand with quarry waste. The 30% replacement of sand with quarry waste increase 6.62% in compressive strength at 28 days. The 25% replacement of sand with Robo sand and 50% replaced ggbs increases 7.38% compressive strength at 7 days. The 30% replacement of sand with Robo sand and 50% replaced ggbs increases 5.70% compressive strength at 7 days.

Table 1.5 Review of sand replace with Quarry waste and cement replace with GGBS

Author	Per replace	Significant contribution
Venu Malagavelli	0%-30%	At 30% replacement of sand with quarry waste and 50% Replacement of cement with ggbs Improved 5% compressive strength

1.5 Review of Research on Sand Replaces with Quarry Waste and Cement Replace with Fly Ash

Chandana Sukesh, Katakam Bala Krishna, P Sri Lakshmi Sai Teja and S Kanakambara Rao [7] used 0%, 10%, 20%, 30%, 40% and 50% replacement of sand with quarry waste. The 30% replacement of sand with quarry waste and water cement ratio 0.5 gives 30 cm slump. The 20% replacement of sand with quarry waste is increase 6.69% compressive strength at 28 days. The 50% replacement of cement with Fly ash is increase 6% compressive strength at 28 days compares to ordinary concrete. In this study 20% replacement of sand with quarry waste improved 6.69% compressive strength.

Table 1.6 Review of research on sand replacement with quarry waste and fly ash

Author	Per replace	Significant contribution
Chandana Sukesh	0%-50%	At 50% replacement of sand with quarry waste and cement replacement with fly ash improved 5% compressive strength
Akshay C. Sankh	0%-75%	The combination of quarry waste and fly ash reduction in cement consumption, increased sulfate resistance, increased resistance to ASR and decreased permeability

Akshay C. Sankh, Praveen M. Biradar, Prof. S. J Naghathan and Manjunath B. Ishwargol [15] says that 20 to 25 percentage of the total production of crushing unit is left out as quarry waste. The 55% to 75% replacement of sand with quarry waste improved compressive strength. The combination of quarry waste and fly ash reduction in cement

consumption, increased sulfate resistance, increased resistance to ASR and decreased permeability. However, the use of fly ash leads to a reduction in early strength of concrete. Therefore, the concurrent use of quarry dust and fly ash in concrete will lead to the benefits of using such materials being added and some of the undesirable effects being negated

1.6 Review of Research on Sand Replacement with Quarry Waste, granulated Blast Furnace Slag and Granite Basalt Fine Quarry Residue.

Medhat S. El-Mahllawy [13] used 50% kaoline fine quarry residue, (10- 40) % granulated blast furnace slag, (10-40) % granite basalt fine quarry residue. The Author has made S_1, S_2, S_3, S_4, S_5 batch for finding Acid resistance brick. The S_1 compressive strength at 1125˚ C is 660 N/mm^2 at 28 days. The S_2 compressive strength at 1125˚ C is improved 7.5% at 28 days. The S3 compressive strength at 1125˚ C is improved 2.27% at 28 days. The S_4 compressive strength is decreases 0.75% at 28 days. The S_5 compressive strength is decreases 28.33% at 28 days. The water absorption of S_1 is 0.50%. The water absorption of S_2 is 0.48% loss. The water absorption of S_3 is increases 0.02% from S_1. The water absorption of S_4 is increases 0.41% from S_1. The water absorption of S_5 is 7.24%. The acid weight loss of S_1 at 56 days is 0.15%. The acid weight loss of S_2 is 0.06%, which is lower than S_1. The acid weight loss of S_3 is 0.18, which is 0.03% higher than S_1. The acid weight loss of S_4 is 0.25%, which is 0.10% higher than S_1. The acid weight loss of S_5 is 0.48%, which is 0.33% higher than S_1.

Table 1.7 Review of Research of sand replace with quarry waste, granulated blast furnace slag and granite basalt fine quarry residue.

Author	Per replace	Significant contribution
Medhat S. El-Mahllawy	0%-100%	At 100% replacement of sand with 50% quarry waste, 20% granite basalt fine quarry residue and 30% granulated blast furnace slag improved 7.5% compressive strength

1.7 Review of Research on Sand Replace with Quarry Waste, Fly Ash and Billet Scale.

Alaa A Shakir, Sivakumar Naganthan, Kamal Nasharudin Mustapha [14] used (10-15) % cement, (50-60) % quarry dust, (0-25) % Fly ash and (0-25) % Billet Scale. The Author has A_1, A_2, A_3, A_4, A_5, B_1, B_2, B_3, B_4 and B_5. The A_1 concrete 28 days compressive strength is 22 N/mm^2. The A_2 concrete 28 days compressive strength is improved 11.36% from A_1. The A_3 concrete 28 days compressive strength is improved 19.54% from A_1. The A_4 concrete 28 days compressive strength is decreases 15.90% than A_1. The A_5 concrete 28 days compressive strength is decreases 65% than A_1. The B_1 concrete 28 days compressive strength is 10.60 N/mm^2. The B_2 concrete 28 days compressive strength is improved 16.98% from B_1. The B_3 concrete 28 days compressive strength is improved 51.60% from B_1. The B_4 concrete 28 days compressive strength is decreases 13.20 % from B_1. The B_5 concrete 28 day's compressive strength is decreases 41.60% from B_1. The Ultra sonic pulse velocity of A_1 is 3.51 Km/s. The UPV of A_2 is decreases 7.40 % than A_1. The UPV of A_3 is decreases 8.83 % than A_1. The UPV of A_4 is decreases 27.63 % than A_1. The UPV of A_5 is decreases 34.18 % than A_1. The UPV of B_1 is 2.67 Km/s. The UPV of B_2 is decreases 0.37 % than B_1. The UPV of B_3 is decreases 0.74 % than B_1. The UPV of B_4 is decreases 10.11 % than B_1. The UPV of B_5 is decreases 22.84 % than B_1.

Table 1.8 Review of Research of sand replaces with quarry waste, fly ash and billet scale

Author	Per replace	Significant contribution
Alaa A Shakir	0%-100%	At 100% replacement of sand with 60% quarry waste, 12.5% fly ash and 12.5% billet scale improved 7.5% compressive strength

2. DISCUSSION

Up to 20% to 35% replacement of sand with quarry waste can improve 8% compressive strength at 28 days. The 50% replacement of sand with quarry waste is decrease 3% compressive strength at 28 days. Up to 20% replacement of sand with quarry waste improves 20% split tensile strength at 28 days. The 30% to 40% replacement of sand with quarry waste decrease 20% split tensile strength at 28 days. Up to 20% replacement of sand with quarry waste improves 6% flexure strength at 28 days. The 25% to 50% replacement of sand with quarry waste is decrease 5% flexure strength at 28 days.

3. CONCLUSION

Based on the above literature review it could be concluded that particle replacement of sand with different alternative up to 30% replacement improved the compressive strength and in case of split tensile strength and flexure strength 20% replacement of sand is optimum. So the work above 30% is not good for strength criteria.

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