Ready Mixed Plastering Mortar Pack Incorporating Quarry Dust

GYDK Silva

Building Materials Research and Testing Division, National Building Research Organization

SSK Muthurathne

Building Materials Research and Testing Division, National Building Research Organization

NBM Ranathunga

Building Materials Research and Testing Division, National Building Research Organization

ABSTRACT: There is a shortage of river sand due to high retrieval of river sand from river beds. In this research, utilization of crushed rock sand by full replacement for river sand for plastering purposes was investigated. Crushed rock is vastly used in Sri Lanka to produce coarse and fine aggregate for construction purposes. Fine rock dust generated in this production process is considered to be waste material and also considered as a deleterious material affecting the quality of concrete fine aggregate. Therefore the objective of this research project was to minimize cost, environmental pollution and wastage by utilizing fines in crushed rock to improve the existing properties of plastering mortar. Plastering mortar properties such as plunger penetration, flow value, bulk density of fresh mortar and flexural and compressive strength of hardened mortar were examined for comparing the performance of crushed rock sand and river sand plastering mortars. It was found that flexural and compressive strength of crushed rock sand mortar showed significantly high strength values compared to river sand plastering mortar for same pre determined compositions by varying the water content to maintain a constant flow value for both mortar types. It was found that the fines content of crushed rock sand plays an important role in determining strength development as well as workability of the plastering mortar. Other mortar properties were observed to be in compliance with general purpose plastering mortar specified in BS EN 998-1:2010

1 INTRODUCTION

Generally, wall plastering is done by using river sand. As a result of rapidly increasing construction activities, demand for river sand kept increasing. High retrieval of river sand from river beds was not possible due to environmental pollution. Various experiments were done to find alternatives for river sand to perform construction activities. Dune sand, offshore sea sand and crushed rock sand were identified as partial replacement of river sand. (Seif 2013)

At present, coarse aggregate required for vivid construction activities is obtained from quarries in different parts of Sri Lanka. Production of coarse aggregate was done using rock crusher plants. In this production procedure, crushed rock sand also known as quarry dust is generated which is regarded as a waste material. Presence of crushed rock dust in aggregate is considered to be harmful and greatly influences the properties of concrete when aggregate are used in concrete. Removal of dust from aggregate is not properly done in crusher plants due to high cost. (Chandana Sukesh 2013)

Effective utilization of quarry dust to produce ready mixed plastering mortar pack for general plastering purposes as a full replacement for river sand plastering was considered during this research project. Objectives of this research project are,

- Waste utilization
- Minimize environmental pollution
- Using quarry dust as full replacement for river sand
- Convenience in use and application of plaster
- Improvement in the quality of concrete fine aggregate by providing incentives by the removal of dust fraction from aggregate

2 METHODOLOGY

2.1 *Sampling of materials*

Quarry dust was obtained from a rock crusher plant. Newly formed quarry dust was sampled from production line of crusher plant. River sand was obtained from market and found to be suitable for use as a fine aggregate. River sand was used as a base for comparing the properties of crushed rock

sand. Sampling was done according to BS EN 932-2: 1999

2.2 *Material properties*

Material properties were tested prior to testing mortar. Quarry dust material properties were tested with comparison to river sand.

- Grading of river sand and crushed rock sand was done using sieve analysis test of respective materials according to SLS 1397:2010 specification and BS EN 933-1:1997.
- Bulk densities of materials were tested according to BS EN 1097-3: 1998.
- Organic impurity contents of materials were tested to identify the presence of harmful organic impurities according to ASTM C40-04.

2.3 *Mortar properties*

Both river sand and quarry dust were sieved using 2.36mm sieve and passing fraction of that sieve was used for mortar properties testing. Materials were oven dried so as to remove any inherent moisture content and then sealed inside polythene covers until testing. Quarry dust mortar properties were tested with comparison to river sand mortar properties. Workability parameter was kept constant for both mortar types while testing mortar properties. Plunger penetration test (BS EN 1015-4: 1999) and flow table test (BS EN 1015-3: 1999) were used to measure the workability of mortar (Mortars n.d.).

Using workability parameter values, W/C ratios of respective mortar types were determined. Bulk densities of fresh mortar were determined according to (BS EN 1015-6: 1999).Flexural and compressive strengths of mortar types were determined after casting of mortar prisms according to BS EN 1015-11: 1999. 7 days and 28 days flexural and compressive strength values were observed for different mix proportions maintaining constant workability values for both mortar types. (Nwofor 2012)

3 RESULTS

Bulk density values of river sand and quarry dust were presented in Table 1.

Table 1. Bulk densities of materials

Bulk density (kg/m^3)	
River sand	1507
Quarry dust	1724

Organic impurity test results indicated that materials were below the harmful organic impurity content level, but organic impurity content of river sand was higher than quarry dust organic impurity content.

Sieve analysis results of respective materials were summarized in Table 2.

Table 2. Sieve analysis results of materials

Sieve size(mm)	Cumulative mass passed % - river sand	Cumulative mass passed % - quarry dust	Specified limits of (0/4)
8	100	100	100
5.6	99.33	99.32	95-100
4	97.81	93.7	85-99
2.8	94.78	82.62	
2	89.39	74.64	
1.4	79.46	67.92	
1	64.98	61.56	
0.5	31.88	49.74	
0.25	8.25	35.78	
0.125	1.35	21.85	
0.063	0.51	12.67	
pan	-	-	

Fig.1. illustrates the graphical representation of sieve analysis results.

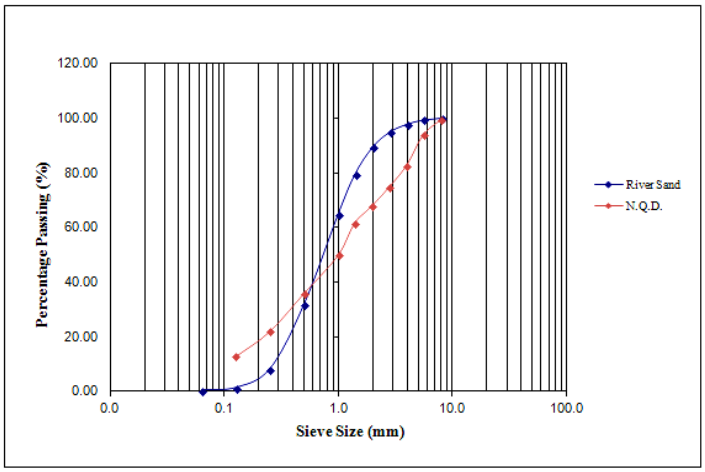

Fig. 1Graphs of sieve analysis of materials

Flexural and compressive strengths of river sand and quarry dust mortar prism results were presented in Table 3.

Table 3. Flexural and compressive strengths of river sand and quarry dust mortar prisms

Trial/I.D	Plunger penetration value (mm)		Flow value (mm)		W/C ratio		Avg. Flexural strength (N/mm^2) (07 days)		Avg. Compressive strength (N/mm^2) (07 days)		Avg. Flexural strength (N/mm^2) (28 days)		Avg. Compressive strength (N/mm^2) (28 days)	
	R.S.	Q.D.	R.S.	Q.D.	R.S.	Q.D.	R.S.	Q.D.	R.S.	Q.D.	R.S.	Q.D.	R.S.	Q.D.
01 1:4 mix proportion	22	22	172	172	0.82	0.96	2.8	4.4	12.4	18.8	4.2	5.1	19.9	21.7
02 1:5 mix proportion	20	22	168	168	1.07	1.18	1.9	4.0	6.9	13.1	2.5	3.7	9.8	14.4
03 1:6 mix proportion	19	24	180	180	1.25	1.45	2.0	2.5	5.8	9.4	2.1	3.1	7.1	11.0

Fig. 2 and 3 represent the 7 days and 28 days flexural strength of river sand and quarry dust mortar with w/c ratio, respectively.

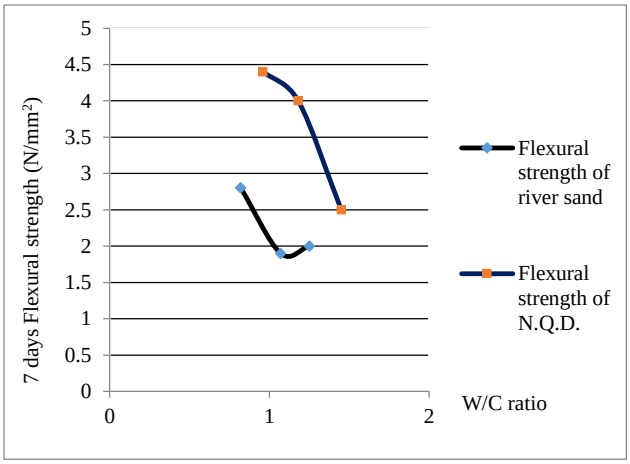

Fig.2 7 days flexural strength vs W/C ratio- comparison of N.Q.D. with river sand

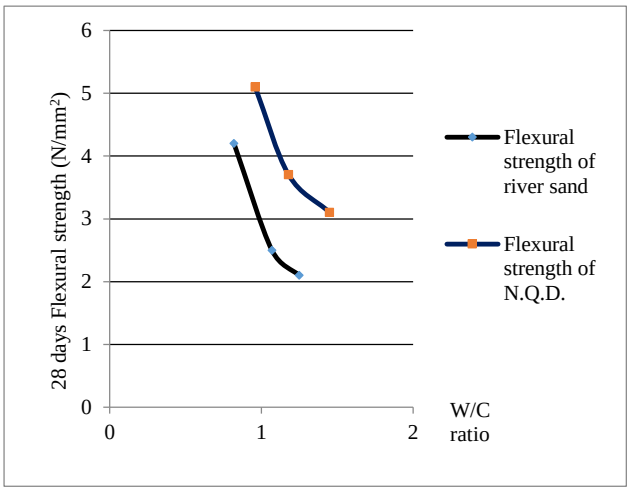

Fig. 3 28 days flexural strength vs W/C ratio- comparison of N.Q.D. with river sand

Fig. 4 and 5 represent the 7 days and 28 days compressive strength of river sand and quarry dust mortar with w/c ratio, respectively.

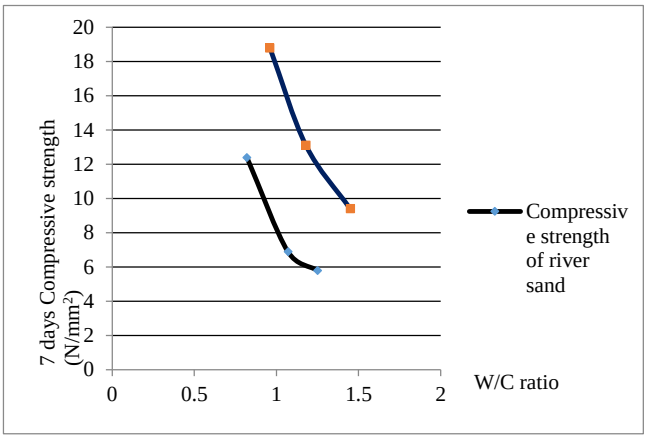

Fig.4 7 days compressive strength vs W/C ratio- comparison of N.Q.D. with river sand

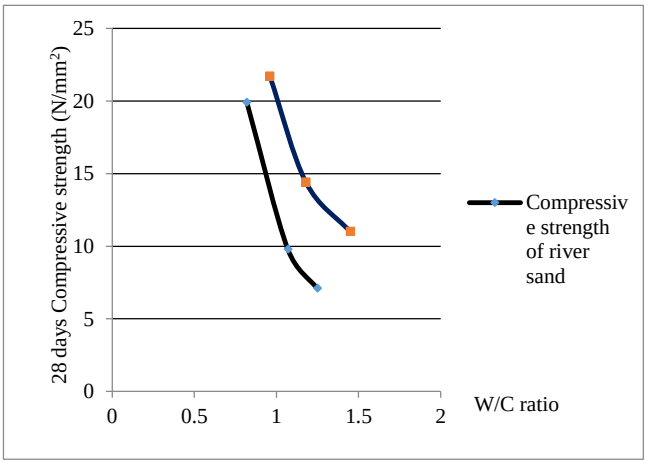

Fig.4 28 days compressive strength vs W/C ratio- comparison of N.Q.D. with river sand

4 DISCUSSION

Due to high fines content in quarry dust, bulk density of quarry dust was significantly higher than river sand bulk density. According to sieve analysis results of respective materials, it was clearly visible that the fines content of quarry dust was significantly higher compared to river sand. The grading curve of quarry dust was irregular where as river sand grading curve was smooth and followed specified requirement of a fine aggregate.

For both types of materials, 28 days flexural and compressive strength values display significantly high values compared to 7 days flexural and compressive strengths. Flexural and compressive strength values of quarry dust mortar prisms show significantly high strength values compared to river sand mortar prisms for all mix proportions under same workability conditions. Hand mixing was involved when preparing mortar for casting mortar prisms. Workability of mortar mixes were kept constant by varying the water content of mortar mixes. With increasing water cement ratio, both flexural and compressive strength of mortar mixes were decreased for all mix proportions.

5 CONCLUSION

Performance of all mortar mix proportions (in respect to all parameters) were increased with increasing cement content. The economy of mortar mix is mainly depending upon cement content. Though performance is superior in 1:4 mix proportions it was excluded from future testing due to high cost. All the mix proportions exceeded the specified strength requirements (Category CS IV). It was very important to maintain same testing conditions for all experiments so as to obtain accurate test results.

1:5 mix proportion was selected for further testing mortar properties such as adhesion of mortar. Particle shape, Fines content as well as particle size distribution of quarry dust highly influences quarry dust mortar properties. Therefore, above mentioned parameters will be varied and further testing will be performed so as to obtain optimum mix proportion of N.Q.D. that will comprise of best performance while minimizing cost.

6 ACKNOWLEDGEMENT

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