WM04
Minimizing the stone dust through a sustainable way: a case study of stone crushing industry of Sylhet

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***Abstract*— this study concentrates on the fine aggregate that is an important factor for strength development in concreting. Generally sand is used as a fine aggregate in Bangladesh. Stone dust produced from stone crushing is the main concern to establish it as an appropriate alternative of sand and to minimize pressure on the sand as natural resources. Huge amounts of stone dust that originated from stone crusher as rubbish is going unused except for the purpose of land filling. From the study it is clear that the stone dust can be used for concreting and by substituting it to normal sand will serve huge solid waste minimization along with considerable waste recovery. It revealed that, stone dust and crushed stone concrete gained about 15% higher strength than that of normal sand.**

INTRODUCTION

Concrete is a stone like material obtained by designing a carefully proportioned mixture of cement, sand and gravel or other aggregates and water to harden in forms of the shape and dimensions of the desired structure [7]. The economy, efficiency, durability, moldability and rigidity of reinforced concrete make it an attractive material for a wide range of structural applications [4]. Aggregate is one of the important constituents which has effect in strength development in the theory that the gaps of coarse aggregate is filled by the fine aggregate and the gapes of fine aggregate is filled by the binding materials [2]. In addition the strength of concrete mainly depends on water/concrete ratio, aggregate gradation, and aggregate size and shape, cement quality, mixing time, mixing ratios, curing etc [5]. Concrete must be both strong and workable, a careful balance of the cement to water ratio is required when making concrete [3]. Fine aggregate are basically sands won from the land or the marine environment. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 9.5mm sieve. For concrete sand FM range is 2.3-3.1[6]. The main constituents of concrete such as sand, stone and water are mainly natural resources. They are not produced in laboratory or in any industry; they are obtained from the nature and processed to make it perfect for aggregate. For example, sand is carried by river water and then collected, and Stones are obtained by crushing of bolder using stone crusher. These resources of engineering materials (sand, stone) are limited and day by day the dependency on them must be minimized. So some other options should be introduced to replace instead of sand and stone. Stone dust is one of such alternative of Sand can fulfill the demand of fine aggregate. In Jaflong and Vulagong a huge numbers of Stone crushers are available, as a result of these extensively labor oriented economic activities, a large number of low income workers live in Jaflong [1] and Vulagong. A huge amount of Dust produced during stone crushing. They are often considered as a waste in the locality. They are not given any interest and thrown here and there. Sometime these stone powders are used for land filling and hence the lands are losing their fertility to produce crops. The main objective of the study is the evaluate relative performance of the concrete made by normal sand and stone dust where the coarse aggregate is crushed stone, in the same way the test is performed using Brick chip as a Coarse aggregate. This study ensures the stone powder or as an appropriate alternative of sand (fine aggregate) in concrete manufacturing as a building materials. As a low cost coarse aggregate Brick Chip is considered to ensure the acceptance and adequacy in construction purposes.

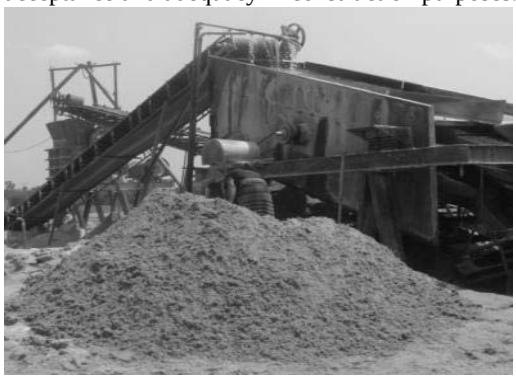

Fig. 1: Stone dust thrown as waste

METHODOLOGY

In order to conduct this study steps like field observation, data collection, analysis, laboratory test, economic consideration, waste minimization practices etc measures are measured. For field observation extensive site visit is conducted including identification of the position of past, present and future condition of the area, extraction of an overall view on the life of labors, their economic status, employment opportunity, number of labors working, economic value of sand and stone dust. Data is actually collected based on survey, interviewing, case studies etc. Location is visited several times to know the existing condition. Different laboratory tests such as grain size analysis, normal Consistency, Fineness, and initial Setting time, Final Setting time etc. for different concrete and mortar materials heve been conducted, which were used in the study. These tests were performed to determine their characteristics. Standard test method ASTM C136 was used for sieve analysis of fine aggregates. The standard

sieve sizes of No. 4, No. 8, No. 16, No. 30, No.50 and No. 100 were used to analyze the fineness of sand. Table I shows the result of sieve analysis of sand and stone dust and other properties of cement. While mixing materials water-cement ratio (w/c) was fixed as 0.485 for all samples. Three varieties of mix design were selected as 1:2.75, 1:3, 1:3.5 etc for mortar and for concrete the mix design were selected as 1:1.5:3; 1:2:4; 1:2.5:5 etc. Compressive strength of mortar and concrete (3 days, 7 days and 28 days) was determined using 2"x2" and 6"x6" cube specimens as per British standard (BS-1881).

Table I: Experimental result of cement and fine aggregate

RESULT

Properties	Values	
Cement	Experimented	Standard
Normal Consistency	27%	22~30%
Fineness	91.2%	minimum 90%
Initial Setting time	64min	≥45 min
Final Setting time	168min	≤ 375 min
Compressive test (28 days)	22Mpa	27.6 Mpa
Fine Aggregate	Normal Sand	Stone Dust
Fineness Modulus	2.53	2.51

The overall information of stone crushing industry of Jaflong and Vulagong was collected based on questionnaire survey. It is found that about 80,000 cft of stone dust generated per month. The overall scenario of two stone crushing zones has been shown on Table II. In order obtain adequacy of the study fineness modulus of sand and Stone powder is calculated. The fineness modulus is almost similar both for stone powder (2.51) and normal sand (2.53). This study shows that the compressive strength for stone powder gives convincing value that can be applied in concreting. And stone dust can be an appropriate alternative of sand.

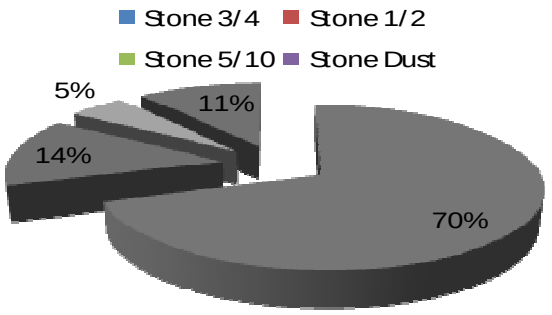

Fig. 2: Diagrammatic presentation of different types of stone found from 100 cft raw stone.

Table II: Overall Scenerio of Jaflong and Vulagong

Location	No. of Crusher	No. of worker involved	Amount of dust produced	Income TK/Capita /day	Working Time (Month)
Vulagong	400	5000	10%	150	9
Jaflong	200	2000	10%	150	9

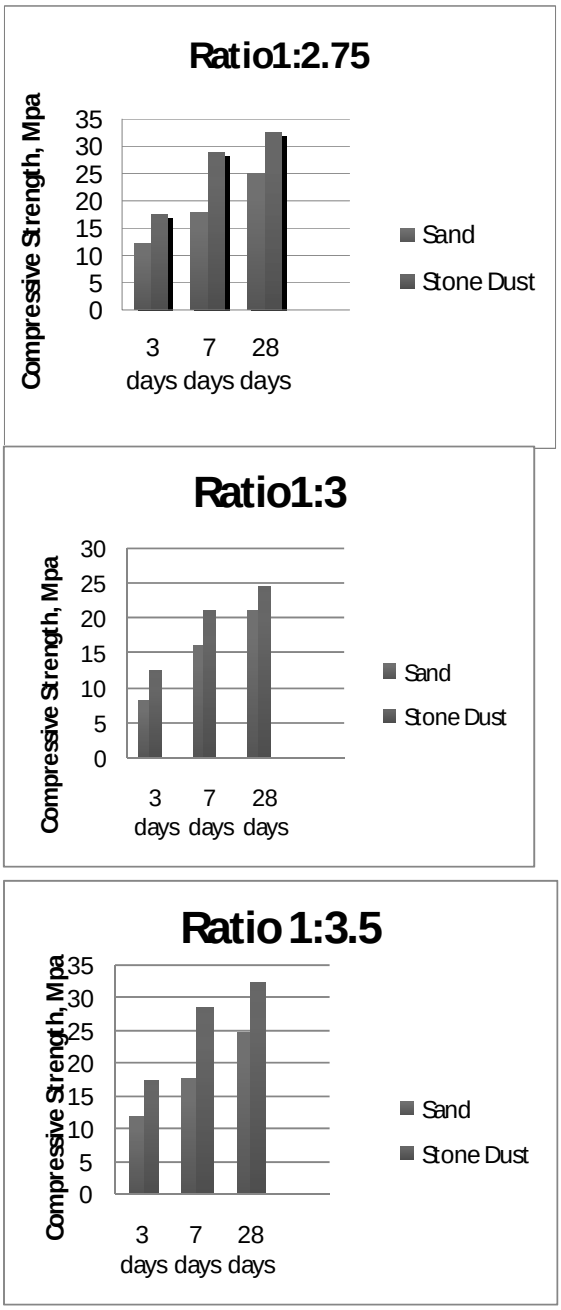

Fig. 3: Compressive strength Vs Duration of Mortar for three different Ratios

Fig. 3 shows the compressive strength of mortar using sand and stone dust. For the 1:2.75 mix ratios stone dust has about 30%, 38% and 23% higher value for 3, 7, and 28 days accordingly from the normal sand and for the ratio 1:3 the compressive strength is 32.85%, 22.8% and 15.39% higher value for 3, 7 and 28 days subsequently. Similarly for the ratio 1:3.5 stone dust has higher compressive strength for 3, 7, and 28 days from that of normal sand.

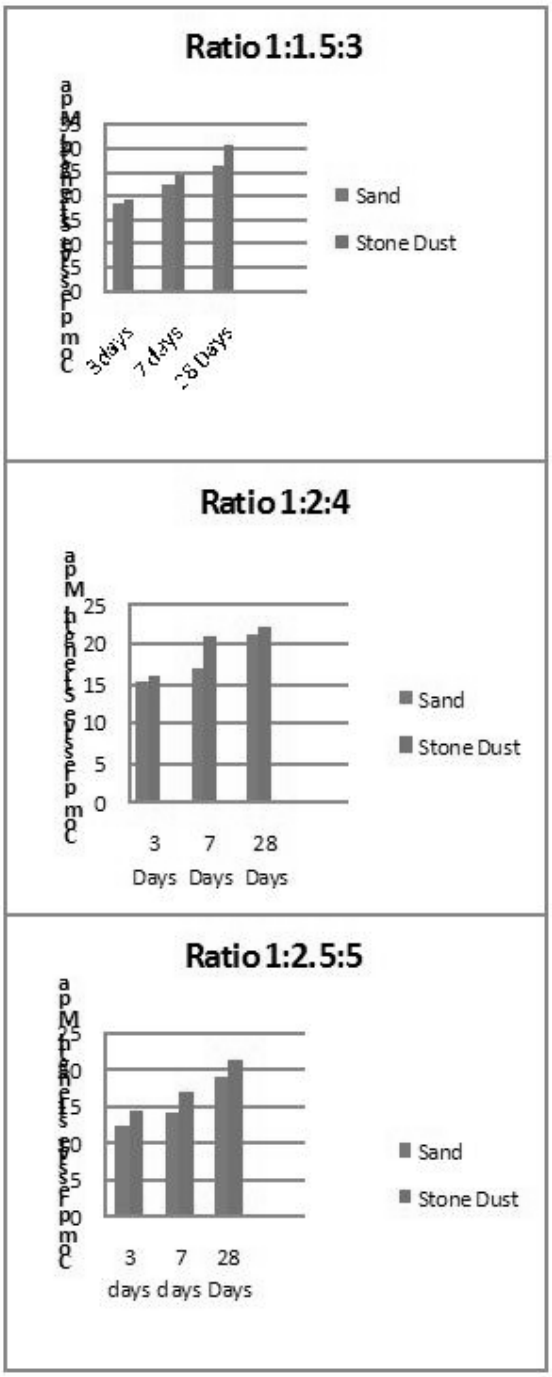

Fig. 4: Compressive strength Vs Duration of concrete for three different Ratios

The compressive strength of concrete block made by crushed stone using normal sand and stone dust has been shown in fig. 4. Here the fig. shows that for ratio 1:1.5:3 stone dust has highest value of compressive strength for 28 days which is 14.75% increased value from that of normal sand. Similarly for the ratio of 1: 2: 4 and 1:2.5:5 stone powder give 4% and 10 % higher value of compressive strength from the normal sand.

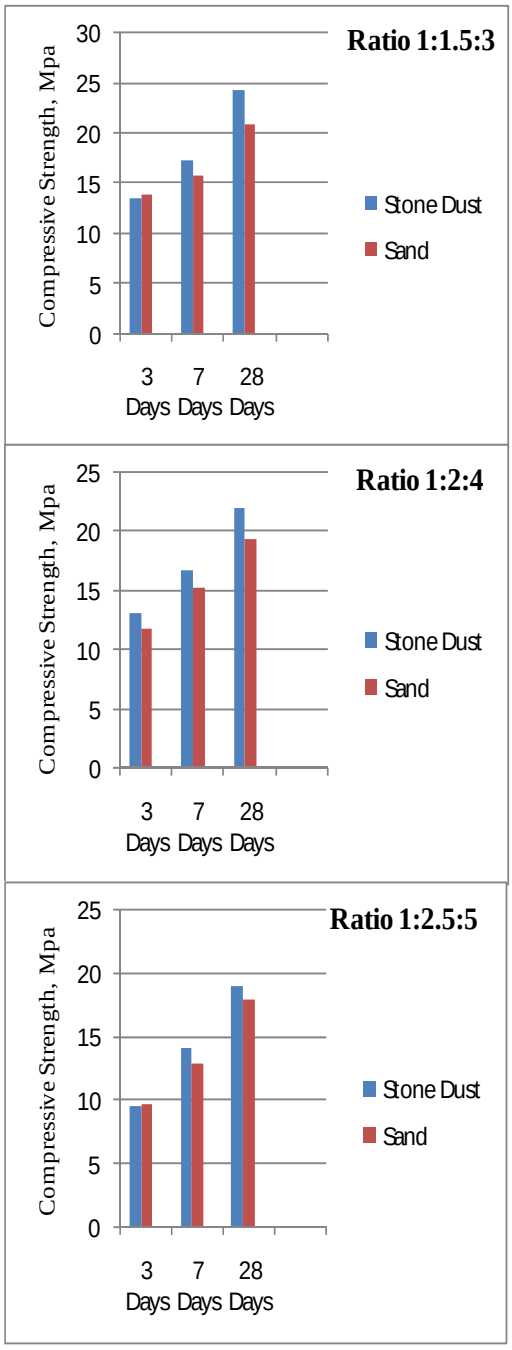

Fig. 5: Compressive strength Vs Duration of concrete (brick chip) for three different ratios

The comparison of compressive strength of concrete block made by brick chip and normal sand and stone dust has been plotted in the fig. 5. According to the fig. for brick chip stone dust has higher compressive strength for all the mix ratios. For the ratio 1:1.5:3 stone dust has 13.74% higher value from the normal sand for 28 days. Similarly for the ratio 1:2:4 and 1:2.5:5, stone powder (for 28 days) has 11.89% and 5.72% increased value from that of Normal sand accordingly.

DISCUSSION

The highest compressive strength of mortar found from stone dust which is 33.02Mpa, shows that the mortar can be

prepared by the powder sand and can easily be used in field. The compressive strength of concrete from powder sand and crushed stone showed a value of 30.62Mpa, a 14.76% higher value from that of normal sand. Using the other mixing ratios stone dust generates higher compressive strength. On the other hand, concrete from brick chip and stone dust produce higher compressive value from that of brick khoa and normal sand. But the compressive strength is low comparing with the crushed stone. This may be due to low quality brick chip, weak workmanship, and wrong proportions of mixing. But for the perspective of Bangladesh, brick chip is economical and available in Bangladesh. So normally for the low cost building it can be used.

CONCLUSION

From the laboratory study, it can be concluded that stone dust is appropriate for medium graded concrete for better performance in terms of strength and economy over normal sand. Khoa/Chip from good bricks has less compressive strength than normal crushed stone concrete. For Mortar, stone dust is well appropriate to choose it as an alternative of sand. According to the collected data it is found that about 100000 cft of stone dust is generated during stone crushing which is almost equivalent to 16,00000 BDT. On the other hand stone dust does not have any economic value. By this stone dust, at least eight 5 storied buildings of 2000 sft can be constructed per month. As in Jaflong and Vulagong stone dust is thrown away without giving any interest so it will be a sustainable solid waste management opportunity to minimize this waste pressure. Actually, the availability of the stone dust is limited and its price is not defined. If the stone powder can have a price value, it is not difficult to market it and use it as an alternative of Sand to minimize the waste pressure in the study areas.

REFERENCES

[1] Ahmed M. 1996. Appropriateness of Stone Shingles in Cement Concrete. ICI Bulletin No. 54 January- March. Indian Concrete Institute, India.

[2] Aziz, M.A., 1995. Engineering Materials. Z and Z Computer and Printers, Dhaka, Bangladesh.

[3] Chamberlain, B (1995). Concrete, A material for the new Stone Age, a mast module, Materials science and technology.

[4] Ferguson P. M., Breen J. E and Jiras J. O. Reinforced Concrete Fundamentals, 5th Edition, 1988, p/1, John Wiley & Sons.

[5] Kabir, Md Imran (2006) " A Study conducted for Medium Grade Cement Concrete Keeping all other parameters same Accept aggregate type, W/C, and mix design ratio" B.Sc Engineering Thesis, Civil and Environmental Engineering Department, Shahjalal University of Science and Technology, Sylhet.

[6] Mobasher, B., 1999, Aggregates: Fineness Modulus. available from: http://www4.eas.asu.edu/concrete/aggregates/sld013.htm.

[7] Sharmin, R., M. Ahmed, A. Mohiuddin and A.L. Forhat, 2006. Comparison of Strength Performance of Concrete with Uncrushed or Crushed Coarse aggregate. ARPN J. Eng. Appl. Sci., 1(2): 1-4