Assessment of Utilizing Marble Stone Dust and Wood Saw Dust as Partial Replacement for Cement and Sand in Concrete

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Abstract

Marble stone dust and wood saw dust have been used in concrete mixes as partial replacement for fine and coarse aggregates separately in recent years. The increase or decrease in strength is due to the addition in the percentage of marble stone dust and wood saw dust. Studies have been conducted on determining the optimum marble stone dust and wood saw dust percentage to meet the desired strength of concrete in construction. In this study, marble stone dust (MSD) and wood saw dust (WSD) were used as partial replacement for cement and fine aggregate in concrete mix respectively. The test samples were prepared by replacing 0%, 2%, 4%, and 6% of cement and fines by weight of concrete with MSD and WSD. The combined effect of MSD and WSD on the workability, compressive strength and flexural strength of concrete was investigated. It was found that both compressive and flexural strength gradually decrease with increase in the percentage of marble stone dust and wood saw dust.

Key words: Concrete; Marble Stone Dust; Wood Saw Dust; Compressive Strength; Workability

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INTRODUCTION

The cost of building construction is increasing regularly such as cement, granite, fine aggregates and coarse aggregate etc. Researchers are paying attention to other low cost materials including wastes and by-products. Recycling wastes into new building materials could be a worthwhile solution not only to the pollution problem, but also to the problem of expensive building materials. leaving the waste materials to environment freely may cause health and environmental problem (Aliabdo et al., 2014). There is a need to investigate the use of such locally available materials in concrete production as a partial replacement of cement and fine aggregate. Moreover, utilization of these wastes marble in concrete production will contribute to the decrease in carbon emission. Marble stone dust is used as reinforcement material in daily life applications, such as ceramic, brick building material etc. (Aruntas et al., 2010).

Rai et al. (2011) partially replaced cement with MSD and reported that with increase in the percentages of MSD the flow ability and compressive strengths of the concrete mix was increased. Pawar and Arvind (2014) Shown that 12.5 % is the optimum limit of MSD replacement for cement beyond which the compressive strength of concrete decreases.

Odero (2015) WSD as partial replacement for sand and shown that the compressive strength of concrete decreases with increase in percentage of wood saw dust. It was stated that 10% partial replacement of sand with wood saw dust provides appropriate strength above the minimum compressive strength for lightweight concrete which is 17 N/mm^2. Oyedepo et al. (2014) reported that wood sawdust can be used for partial replacement of sand up to 25 % without adversely affecting concrete strength.

Due to limited studies the behavior of MSD and WSD as partial replacement for cement and sand is yet not fully understood. In this study we analyze the effect of MSD and WSD on the properties of fresh and harden concrete. The cement and fine aggregate were partially replaced by MSD and WSD respectively with 0 %, 2 %, 4 %, and 6 %.

MATERIALS AND METHODS

The materials used in this study were ordinary Portland cement, fine aggregate and coarse aggregate were obtained from Airport bypass road. Marble stone dust and wood saw dust were purchased from Madina

Marble Factory Airport road Quetta and Sham Uddin wood shop Nawa Killi main road Quetta respectively. In this study, the batching by weight method was adopted. Preliminary mixes of 1:2:4 (cement and MSD: fine sand and WSD: coarse aggregate) were investigated with water/cement ratio of 0.65.

Water was also weighted and placed into the concrete mixer and mixed constantly until the batch was thoroughly mixed and then casted into 6 × 6 × 6 in^3 and 6 × 6 × 18 in^3 size moulds, as shown in Figure 1. The moulds were assembled and properly lubricated to insure smooth removal of hardened concrete cubes and beams. Concrete cubes and beams were prepared in percentage by weight of coarse aggregate (crushed 12.5-25mm) to WSD as coarse aggregate and cement to MSD as cement in the order 100:00, 98:02, 96:04, 94:06, as shown in Table 1. Specimens were made in accordance with BS-1881 specifications. A total of 72 concrete specimens (36 cubes and 36 beams) were produced and used for compressive test and flexural test respectively.

The specimens were cured in ordinary water by complete immersion method and tested for strength at 07, 14 and 28 days. All the specimens were weighed before testing and the densities were measured. The specimens were taken out of the water and left outside in open air for about one hour before testing. The workability of the specimens were test in accordance with ASTM-C-143. Flexural strength and compressive strengths of the samples were tested in accordance to ASTM-C-239 and BS-1881 respectively with the use of universal testing machine.

Table 1: Mix proportions used in this study

% of MSD & WSD	Days	No. of cubes	No. of Beams
0 %	7	3	3
	14	3	3
	28	3	3
2 %	7	3	3
	14	3	3
	28	3	3
4 %	7	3	3
	14	3	3
	28	3	3
6 %	7	3	3
	14	3	3
	28	3	3

Figure 1: Beam and Cubes Casting

RESULTS AND DISCUSSION

The slumps tests on samples of the MSD and WSD concrete mix show that the workability decrease with increase in the MSD and WSD percentage. Figure 2 shows the variation of slump from high to low workability with the addition of 0 to 6 % of MSD and WSD. The decrease in the workability of concrete can be due to the absorption of water by marble stone and wood saw dust in concrete.

The flexural strength measured from center point loading test are given in Table 1. The results show slight decrease in strength with increase in MSD and WSD percent, as shown in Figure 3. The strength was reduced by 10 percent with the addition of 2 % MSD and WSD for all curing periods. At 6 % MSD and WSD the reduction in strength was 17% for all curing periods. Which indicate that the rate of strength reduction decreases with increase in the amount of MSD and WSD. The strength reduction may be due to the high rate of water absorption of WSD (Usman et al., 2012).

Table 2 presents the compressive test results of MSD and WSD concrete cubes. The compressive strength results so show decrease in strength with increase in MSD and WSD percent, as shown in Figure 4. The strength was reduced by 22 percent with the addition of 2 % MSD and WSD for all curing periods. At 6 % MSD and WSD the compressive strength was reduced by almost 22 % for all curing periods.

Table 2: Flexural strength of MSD and WSD concrete

Days	Sample No.	0% MSD & WSD	2% MSD & WSD	4% MSD & WSD	6% MSD & WSD
		Strength (Psi)	Strength (Psi)	Strength (Psi)	Strength (Psi)
7	1	502.5	450.4	431.6	418.2
	2	511.2	455.9	435.9	420.8
	3	512.1	456.4	436.8	425.9
	Average	**508.6**	**454.3**	**434.8**	**421.6**
14	1	710.2	640.2	600.4	581.5
	2	712.5	647.7	642.2	570.9
	3	706.9	642.5	604.9	588.7
	Average	**709.9**	**643.5**	**615.8**	**580.4**
28	1	789.4	702.2	670.1	650.2
	2	778.2	701.4	679.9	659.5
	3	785.1	695.1	672.1	654.1
	Average	**784.2**	**699.6**	**674.1**	**654.6**

CONCLUSION

This research concluded to find out the comparative assessment of partial replacement of cement and fine aggregates by marble stone & wood saw dust. The workability of WSD and MSD concrete was decreased, which could be due to the absorption of water by marble stone & wood saw dust in concrete. The flexural strength and compressive strength of WSD and MSD concrete decreases with increase in the amount of WSD and MSD. However, the flexural strength and compressive strength was reduced by only 17 and 22 % respectively with 6 % of WSD and MSD used as partial replacement for sand and cement respectively. The decrease in compressive strength may be due to the lesser formation of CSH, Calcium hydroxide ($Ca(OH)_2$) and hydration phases.

Table 3: Compressive strength of MSD and WSD concrete

Days	Sample No.	0% MSD & WSD	2% MSD & WSD	4% MSD & WSD	6% MSD & WSD
		Strength (Psi)	Strength (Psi)	Strength (Psi)	Strength (Psi)
7	1	1488.3	1307.9	1217.7	1159.1
	2	1518.1	1334.1	1242.1	1182.3
	3	1465.9	1288.3	1199.5	1141.7
	Average	**1490.8**	**1310.1**	**1219.75**	**1161.02**
14	1	2060.8	1810.9	1686.1	1604.9
	2	2101.9	1847.2	1719.8	1636.9
	3	2029.8	1783.8	1660.8	1580.8
	Average	**2064.18**	**1813.98**	**1688.88**	**1607.56**
28	1	2266.8	1992.1	1854.7	1765.4
	2	2312.2	2031.9	1891.8	1800.7
	3	2232.8	1962.2	1826.9	1738.9
	Average	**2270.6**	**1995.38**	**1857.77**	**1768.32**

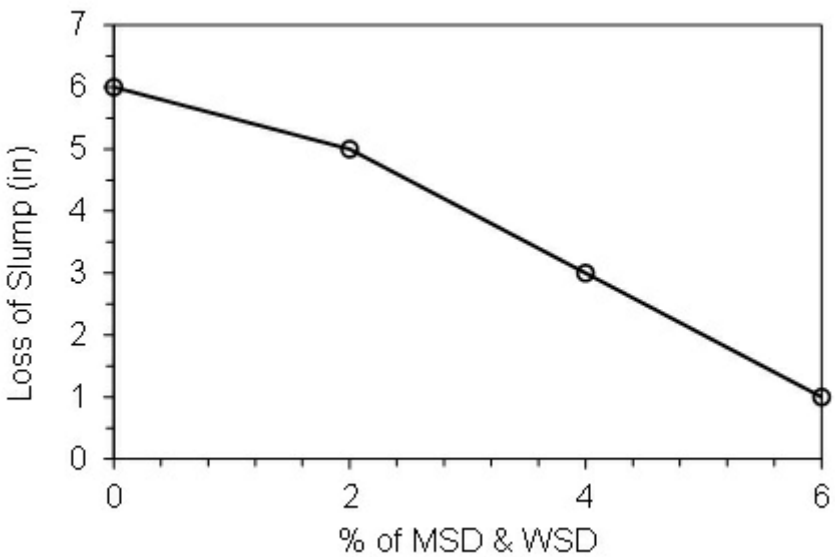

Figure 2: Loss in Workability with Different %age of MSD and WSD

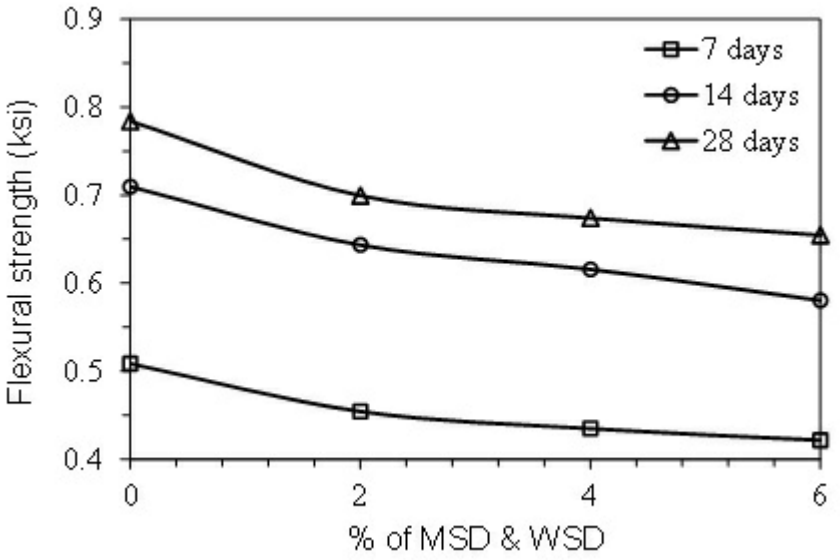

Figure 3: Decrease in Flexural Strength with Increase % of MSD and WSD

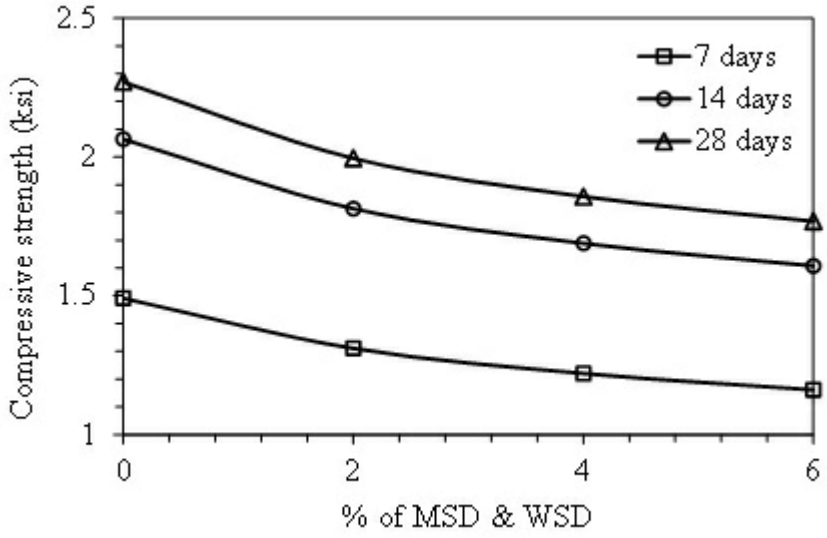

Figure 4: Decrease in Compressive Strength with Increase % of MSD and WSD

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