Influence Of Marble Waste And Crusher Dust On Properties Of Cement Mortar: A Review

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Abstract- Rapid production of cement with rapid construction all around the world lead to rise in the enormous emission of green house gases. While on the other side unlimited extraction and consumption of natural river sand is also threatening issue for the society. A major concern these days is the disposal of stone wastes. Marble and crusher dust are the leading waste of stone industries which are responsible for various unpleasant effect on the environment and living being in contact with them directly or indirectly. The reason for this review study is to resolve the solid waste issues created by marble waste and crusher dust. This review paper present the influence of marble powder waste and crusher dust as fine aggregate and cement replacement in cement mortar.

Key word- marble waste, crusher dust, cement mortar, compressive strength, sustainability

I. INTRODUCTION

In the era of today’s modern world rapid growth in infrastructure development results in the depletion of available limited natural resources. To save these available limited natural resources more research and studies were conducted by various researchers to utilize various waste materials in concrete and mortar to produce sustainable products. The purpose of sustainability is that life on the earth can be sustained for coming future and there are three segments of sustainability: environment, economic system, and society. To meet its purpose, sustainable development must ensure that these three components remain healthy and balanced. On the other hand, the environment is generally the most fundamental element and an engineer or architect uses sustainability to intend having no net poor effect on the atmosphere. The focus of a good national development is to look inwards with intent to mobilize all natural resources for economic purposes.

With rapid development of construction industries in country requirement of cement and Natural River sand is also increasing with same scale. Production of cement lead to results in emissions of green house gases in the environment while on the other hand excessive consumption of natural river sand results in disturbance of ecology of the environment.

Rajasthan state has around 4000 marble mines and 1100 marble processing units which are spread over in 16 districts. With the increase in demand for these stones throughout the country, number of marble processing units and quarries in Rajasthan has significantly gone up in the past decade [1]. As the marble processing industry continues to expand, large amounts of waste in the form of marble slurry are generated which adversely affect the environment. Large quantity of waste stone dust is available near crusher plants as it is kept in abundance [2]. Accumulation of these stone waste adversely affect the environment and underground water. Use of crusher stone dust as an alternative to expensive and depleting sand in mortar will curtail the enormous consumption of river sand and also minimize the accumulation of stone waste.

This review paper shows a detailed review about utilization of marble powder and crusher dust as fine aggregate and cement replacement in cement mortar.
II. STRENGTH PROPERTIES OF CEMENT MORTAR CONTAINING MARBLE WASTE

2.1 Marble waste as cement replacement
2.1.1 Compressive strength.
Rai et al. [3] obtained the 28 days compressive strength of cement mortar having cement/sand ratio of 1:3 containing waste marble powder. Waste Marble Powder was used as cement replacement ranging from 5% to 20% by weight of cement. Results showed decrement in compressive strength when waste marble powder was increased.

Singh et al. [1] investigated the behaviour of cement mortar and concrete by replacing cement with marble powder. Marble powder was used in the study ranging from 10% to 25% with increment of 5% by weight of cement. Result showed that compressive strength increase with increase in replacement up to 10%, after that decrease in compressive strength was observed. Reason behind this increase in trend is due to micro filler effect of marble slurry but after 10% replacement level decrease in strength was observed which is may be due to reduction in C\textsubscript{2}S and C\textsubscript{3}A required for hydration process.

Vardhan et al. [4] obtained the 3, 7 and 28 days compressive strength of cement mortar having binder/sand ratio of 1:3. Cement was replaced by Marble powder ranging from 10% to 50% with increment of 10% by weight of cement. Figure 1 shows the variation of 3 days, 7 days and 28 days curing period compressive strength of cement mortar at various replacement level of marble powder as cement. From figure 1 it was observed that inclusion of 10% marble powder at all ages of curing slightly increases the compressive strength of cement mortar and thereafter compressive strength decreases with increase in replacement level compared to that of control mortar.

![Figure 1. Variation of compressive strength with replacement of marble powder.](image)

2.2 Marble waste as sand replacement
2.2.1 Compressive strength.
Rai et al. [3] obtained the compressive strength of cement mortar having cement/sand ratio of 1:3 containing waste marble powder. Waste Marble Powder was used as fine aggregate replacement ranging from 5% to 20% by weight of fine aggregate. Experimental test results revealed that maximum compressive strength was obtained a 10% partial replacement of sand by marble powder. Further, increase in replacement level of marble powder result in decrease in value of compressive strength.
Khayalia et al. [5] determined the strength properties of lean mortar mix (1:6 binder/sand ratio) containing marble waste as sand replacement. Crushed marble waste was used as fine aggregate replacement ranging from 25% to 100% with 25% increment by volume of sand. Figure 2 shows the variation of compressive strength with respect to crushed marble waste at 7 and 28 days of curing age.

![Figure 2. Variation of compressive strength with substitution of marble powder.](image)

It was observed from the figure 2 that with increase in substitution level of marble powder there was increase in compressive strength at 28 days curing period and decrease at full replacement (100% substitution). At each substitution level of sand by marble waste value of compressive strength was more than that of control specimen.

K.I. Syed Ahmed Kabeer and Ashok Kumar Vyas [6] evaluated the various properties of cement mortar mix containing marble powder as fine aggregate replacement. Mortar mix proportions of 1:3, 1:4, 1:5 and 1:6 (cement: fine aggregate) by volume were prepared. Fine aggregate was substituted by marble powder from 0% to 100% in steps of 20%. Figure 3 shows the variation of 28 days compressive strength with substitution of sand by marble powder. It was observed from figure 3 that at 20% substitution level maximum compressive strength was found observed. Compressive strength of cement mortar mixes having 60% substitution of sand by marble powder perform on par with the corresponding control cement mortars.

![Figure 3. Variation of compressive strength with percentage substitution of sand by marble powder.](image)
III. STRENGTH PROPERTIES OF CEMENT MORTAR CONTAINING STONE DUST

3.1 Stone waste as cement replacement

3.1.1 Compressive strength.
Hoque et al. [7] determined the effect of stone dust as partial replacement of sand and cement in cement mortar. In this investigation authors utilized stone dust as fine aggregate replacement ranging from 0% to 50% with increasing step of 25%. Also, cement was replaced by stone dust up to 5% by weight of cement in cement mortar mix of cement/sand ratio 1:2.75. Figure 4 shows the variation of compressive strength at 7 days and 28 days curing period. It was observed from figure 4 that maximum strength was observed at 25% replacement level of stone dust. The lowest strength value 3792 psi is the outcome of 50% sand replacement and 5% cement replacement. Stone dust as cement replacement decrease the strength properties of cement mortar mix. Similar variation in compressive strength was observed for 28 days curing period.

![Figure 4. Variation of 7 days and 28 days compressive strength of cement mortar mix containing stone dust](image)

3.1.2 Tensile strength.
Hoque et al. [7] determined the effect of stone dust as partial replacement of cement on tensile properties of cement mortar. Figure 5 shows the variation of tensile strength at 28 days curing period. It was observed from figure 5 that maximum strength was observed at 50% replacement level of stone dust without cement replacement. When cement is partially replaced by there is decrease in value of tensile strength was observed. This variation may be due to the fact that water absorption of stone dust is higher than that of normal sand.

![Figure 5. Variation of 28 days tensile strength of cement mortar mix containing stone dust](image)
3.2 Stone waste as sand replacement

3.2.1 Compressive strength.

Hoque et al. [7] determined the strength properties of cement mortar containing stone dust as partial replacement of sand and cement in cement mortar. In this study fine aggregate was partially replaced by stone dust ranging from 0% to 50% with 25% increment. Also, cement was replaced by stone dust up to 5% by weight of cement in cement mortar mix of cement/sand ratio 1:2.75. Figure 6 shows the variation of compressive strength at 3 days and 28 days curing period. It was observed from figure 6 that maximum strength (4772 psi) was observed at 25% replacement level of stone dust and for 100% cement. By substitution of 5% of cement this value falls down and it is approximately 62% of the value obtained for 100% cement. Similar variation in compressive strength was observed for 28 days curing period.

![Figure 6. Variation of 3 days and 28 days compressive strength of cement mortar mix containing stone dust](image)

Mahzuz et al. [8] determined the influence of stone waste as fine aggregate replacement in cement mortar mixes 1:2.75, 1:3 and 1:3.5. It has been found that stone dust as fine aggregate replacement enhances the compressive strength property of control specimen at every mixes.

Kaushik C Gamit and Dr. Harshvadan S Patel [9], evaluated the compressive strength property of cement mortar containing stone dust as fine aggregate replacement. In this study cement mortar mixes in proportion of 1:3 and 1:6 (cement:sand) were used. Fine aggregate was replaced by stone dust at replacement level of 0%, 25%, and 50% by weight of sand. The compressive strength of mortar was observed at 3, 7, and 28 days of interval as shown in figure 7. It was observed from the figure 7 that compressive strength of control mixed at cement mortar mix 1:3 obtained at 3, 7, and 28 days is 10.48 MPa, 14.06 MPa, and 22.27 MPa. For 50% replacement of stone dust with sand, compressive strength was observed as 10.07 MPa, 12.46 MPa and 23 MPa.

![Figure 7. Variation of compressive strength of cement mortar mix at various age of curing and at varied replacement level of stone dust](image)
3.2.2 Tensile strength.
Hoque et al. [7] evaluated the tensile strength property of cement mortar mix containing stone dust as sand replacement up to 50% with 25 % increment. It was found from the study that with increase in replacement level of stone dust these was increase in tensile strength was observed. This variation may be due to the fact that water absorption of stone dust is higher than that of normal sand.

IV. CONCLUDING REMARKS
The utilization of marble waste and crusher dust in various forms in cement mortar as cement and fine aggregate replacement has been broadly investigated in recent years. This review paper has presented an assortment of aspects on marble waste and crusher dust and its usage in cement mortar which may be summarized as:
1. Utilization of marble powder as cement replacement in cement mortar mix modifies the compressive strength properties depending upon the cement sand ratio and other factors.
2. Substitution of river sand by marble powder also modifies the compressive strength properties of cement mortar mix. From the available studies it can be concluded that at minimum 10% replacement of sand by marble waste enhance the compressive strength property of cement mortar mix depending upon the cement sand ratio and other factors.
3. Using crusher dust as partial replacement of cement decreases the strength properties of cement mortar.
Utilization of marble waste and crusher dust as cement and sand replacement in cement mortar minimize the problem associated with the accumulation of marble waste and emission of green house gases due to cement production. Hence utilizing these waste stone materials in cement mortar lead to produces sustainable mortar which is advantageous to the society and environment.

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