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# Brick Dust and Limestone Powder as a Filler Material in Concrete: Sustainable Construction

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**Abstract:** The purpose of this study is to utilize the waste in concrete. Brick dust and limestone powder is wasteful material which on dumping not only occupy land but also it has environmental problems which is hazardous to livings. This waste is generated in brick kilns, brick masonry construction sites and during transportation and limestone waste is generated from fine material associated with coarse aggregate production. By reutilizing brick dust and limestone powder the problem could be solved up to some extent. In this investigation, combine brick dust and limestone powder were used in plain concrete to check its fresh and hardened properties. Brick dust and limestone powder was combination for used to check the workability and strength of concrete, using the water-cement ratio of 0.5 which was kept constant during study. Three samples were cast for each concrete mix at age 28 days with 0, 10, 15 and 20% by weight of cement incorporation of brick dust and limestone powder. The all samples test results reveal that added of brick dust and limestone powder shows slightly lower workability than control sample. However, strength results were quite competitive with 15% combination of brick dust and limestone powder shows higher compressive strength. This study shows that incorporation of combination brick dust and limestone powder can be can be effectively used in construction applications.

## INTRODUCTION

Concrete is the most popular construction material and consumed is so much in the world. Libya, as a developing country, suffered a critical lack of suitable infrastructure and buildings in almost all parts. In addition, reconstruction and develop in construction industry will be need more concrete and raw materials. Concrete is a very adaptable construction material but it is not very green and this effect comes mainly from the effect of the chemical composition in the Portland cement. Concrete is known to be a simple material in form but with a very compound internal nature. In contrast to its internal complexity, durability and economy of concrete have made it the most frequently used building material in the world. The concrete in which common ingredients, aggregate, water, cement is used is known as ordinary concrete. It is also named normal weight concrete or

normal strength concrete[1]. Good quality of concrete produce by knowing what factors affect compressive strength and knowing how to manipulate those factors to achieve the required strength. In addition to choosing a high-quality Portland cement, enhance aggregates and then improve the combination of materials by varying proportions of cement, water, aggregates and admixtures. The cement and water will procedure a paste that strengthens as a result of a chemical reaction between the cement and water. The paste performances as glue, compulsory the aggregates (sand and gravel or crushed stone) into a solid rock-like mass. The quality of the paste and the aggregates dictate the engineering properties of this construction material. When choosing aggregates, the strength of the aggregate, the optimal size of the aggregate, the bond between the cement paste and the aggregate and the surface characteristics of the aggregate should be considered. Any of these properties could limit the ultimate strength of the concrete. Sometimes other materials are combined into the batch of concrete to create specific characteristics these additives are named admixtures[2]. A number of studies have been carried out to find better/cheaper aggregates and cement along with best practice of waste materials in construction[3-5].

Brick and limestone are one of the most important materials used in buildings since ancient times. However, its powder obtained from crashed limestone and brick powder has severe effects on the environment and health. Disposal of the dust of brick and limestone material of the construction industry is one of the environmental problems worldwide today. It affects the environmental ecosystem in which living things are interacted by nonliving things and being affected. In most of the places of Libya the disposed of in open as profitless waste materials and not sufficiently used in any construction manufacturing. The suitable management and disposal of this waste is a worldwide concern to environmental integrity[3]. Influence on fresh concrete due to mineral admixtures shows difference in mechanical and durability properties compared to plain concrete[6]. Huge amounts of limestone and marble are quarried and utilized worldwide for several purposes. Marble is a refined form of limestone and dolomite created by their metamorphism. Through clipping and sawing operation of limestone, Massive amounts of crumbs, fine powder and slurry are created as waste product. Generally, it is supposed that 60-70% of the stone is wasted in this procedure in the form of crumbs, dust and slurry out of which around 30% is in the form of fine dust[7]. Bricks are made up of various kinds of clays and other materials such as sand. Clay composed up of 20-30% Alumina, 50-60% Silica and other carbonates and oxides. Clay is responsible for the pozzolanic behavior of brick. Clay itself has no pozzolanic properties but when fired together with lime through brick manufacture procedure it gains pozzolanic nature[8]. The application of concrete has been increasing throughout the world with the various method used to improve the performance and strength of concrete. The inspired researchers from different institutes to integrate materials such as brick dust and limestone powder in concrete manufacture to enhance the quality of concrete. However, this study will represent the use of brick dust and limestone powder as filling material in concrete mix. The importance of this study is to examine the potential utilize of an abundantly available waste product in construction industry herewith resolving its disposal problems along with potential of gain a better product, i.e., concrete with enhanced characteristics. Environment is benefitted as a consequence.

## MATERIALS AND METHODS

### Experimental program

**Materials:** Concrete mixes that is made of ordinary Portland cement confirming by ASTM C150-99a, Coarse aggregate was obtained from the crashed stone had a 12-mm nominal size, the specific gravity was 2.65. The sea sand was used as a fine aggregate the specific gravity was 2.66 its grading was within BS 882-19992, tap water is used for mixing and curing of concrete and the combination of brick dust and limestone powder with fineness namely (75 mic) (Fig. 1).

**Mix design:** The proportions were mixed randomly. The cement, sand and coarse aggregate were weighed according to a mix proportion of 1:1.5:3. Mix proportions and characteristics of ratios of combination brick dust and limestone powder in the concrete are presented in Table 1.

**Preparation and casting of test specimens:** The experiments were conducted in the concrete laboratory, concrete mixes were made in a power-driven 50-L revolving type drum mixer. The coarse aggregate, fine aggregate, cement and combination brick dust and limestone powder filling materials ratios. The materials were mixed and distributions then water was added to the mix incrementally to attain the consistency required. After mixing, a portion of the fresh concrete was placed aside for fresh properties determination. Slump tests of fresh concrete were measured. The moulds used for the

Fig. 1: Brick dust and limestone powder

Table 1: Mix proportions of concrete

| Samples | Substances weights (kg $m^{-3}$) Cement | Coarse aggregate | Fine aggregate | Water | Brik dust filler ratio (%) | Limestone powder filler ratio (%) | Combination brick dust and limestone powder (kg $m^{-3}$) |
|---|---|---|---|---|---|---|---|
| M0 | 400 | 600 | 1200 | 200 | - | - | - |
| M1 | 400 | 600 | 1200 | 200 | 5 | 5 | 40 |
| M2 | 400 | 600 | 1200 | 200 | 7.5 | 7.5 | 60 |
| M3 | 400 | 600 | 1200 | 200 | 10 | 10 | 80 |

concrete cubes are casted plastic with dimensions of 150×150×150 mm for compressive strength test. All the specimens were kept for 24 h in molds at a temperature of about 25°C in the casting room then cured in the water tank for the specified time at approximately 25°±2°C for age 28 days.

## RESULTS AND DISCUSSION

**Slump test:** The results for slump test of combination brick dust and limestone powder concrete are shown in Table 2. The data are recorded and being shown to observe the relation between percentages of combination brick dust and limestone powder and slump value. The value of slump for different percentages of combination brick dust and limestone powder is then plotted as shown in Fig. 2. Results shown slump against different percentages of combination brick dust and limestone powder. The results shown clear that slump reduce with increase percentages of combination brick dust and limestone powder. It is suitable since continuous hydration procedure will produce calcium silicate hydrate to fill the holes between the cement particles and aggregate. As an outcome, setting of the concrete will decrease the fluidity of concrete, henceforth, decrease the slump also. When observation is done on the content of combination brick dust and limestone powder, increase in percentage of the combination brick dust and limestone powder decreased the workability of concrete, since combination brick dust and limestone powder which have higher water demands than plain concrete without brick dust and limestone powder. However, over percentage of combination brick dust and limestone powder leaded to high slump loss which given not true slump that as what we expect and desire.

**Compressive strength test:** Table 3 summaries the results for hardened concrete, then Fig. 3 shown the variation of compressive strength with different brick dust and limestone powder percentage. The compressive strength of concrete increased for 10, 15 and 20% ratios of combination brick dust and limestone powder additive. The results illustrate that compressive strength increases along with increase the percentage of brick dust and limestone powder. The maximum value of 28-day compressive strength was obtained as 44.7 MPa at 15% ratios of combination brick dust and limestone powder additive comparative with control mix as 34.4 MPa and the minimum was obtained for the 10% ratios of combination brick dust and limestone powder additive as 34.6 MPa. A close observation of the results exhibits that

Table 2: Effect of combination brick dust and limestone powder on workability

| Mix No. | Brick dust and limestone powder (%) | Slump (mm) |
|---|---|---|
| M 0 | 0 | 170 |
| M 1 | 10 | 135 |
| M 2 | 15 | 100 |
| M 3 | 20 | 90 |

Table 3: Effect of combination brick dust and limestone powder on compressive strength

| Mix No. | Brick dust and limestone powder (%) | Compressive strength (MPa) |
|---|---|---|
| M 0 | 0 | 34.4 |
| M 1 | 10 | 34.6 |
| M 2 | 15 | 44.7 |
| M 3 | 20 | 40.0 |

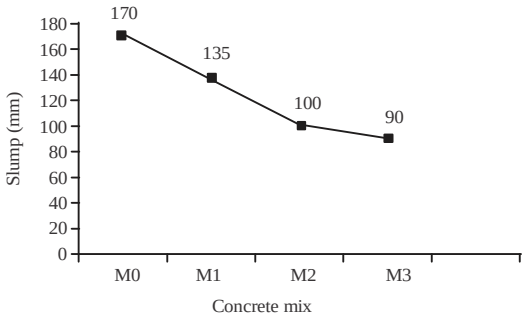


Fig. 2: Effect of combination brick dust and limestone powder on workability

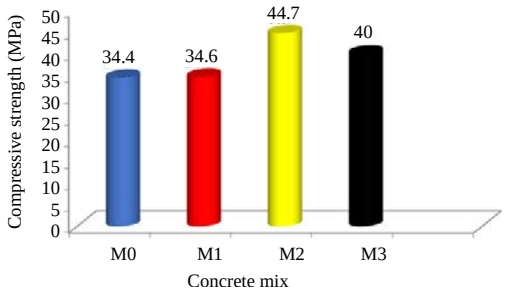


Fig. 3: Compressive strength of various normal concrete mixes at 28 days

high percentages of combination brick dust and limestone powder increase the compressive strength compared with control spermines was obtained as 40 MPa at 20% ratios of combination brick dust and limestone powder additive. Generally, for 15% of combination brick dust and limestone powder considerably improved the compressive strength with respect to control specimens. This improvement in strength, due to the initial filling of voids by combination brick dust and limestone powder, is attributed to the pozzolanic action of combination brick dust and limestone powder and densification of the concrete matrix. With other composition parameters remaining constant, the results indicate that the optimum combination brick dust and limestone powder percentage is not a unique one but varies from 10-15 and 20% percentages.

## CONCLUSION

Based on this study, the following conclusions are made regarding the properties of concrete with additive mineral admixtures such as combination brick dust and limestone powder:

Addition of combination brick dust and limestone powder to concrete can be conveniently with the present-day technology as this study has shown that it is possible to produce concrete using the combination brick dust and limestone powder as filling materials.

Test results indicate that the concrete produced with combination brick dust and limestone powder tends to increase strength more than conventional concrete. The presence of combination brick dust and limestone powder increases the strength of concrete.

As a comparative the results indicated that compressive strengths of combination brick dust and limestone powder concrete specimen at 15% were higher than those of normal concrete specimen so determined the optimum amount of combination brick dust and limestone powder.

Environmentally using of combination brick dust and limestone powder in the concrete for construction is doing the environment a good deal in utilizing waste.

## REFERENCES

01. Alsadey, S., 2016. The effect of different mineral admixtures on characteristics of concrete. Concr. Res. Lett., 7: 98-103.
02. Alsadey, S., 2015. The effect of local available materials on the properties of concrete. Int. J. Life Sci. Eng., 1: 140-144.
03. Corinaldesi, V., G. Moriconi and T.R. Nail, 2010. Characterization of marble powder for its use in mortar and concrete. Contruction Building Mater., 24: 113-117.
04. Demirel, B., 2010. The effect of the using waste marble dust as fine sand on the mechanical properties of the concrete. Int. J. Phys. Sci., 5: 1372-1380.
05. Surendra, B.V. and T.N. Rajendra, 2016. An experimental investigation on strength properties of concrete with partial replacement of fly ash and metakaolin & with M. sand as fine aggregate. Int. Res. Eng. Technol., 3: 2150-2153.
06. Aukor, F.J. and M.I. Al-Qinna, 2008. Marble and environmental constraints: Case study from Zarqa governorate, Jordan. Jordan J. Earth Environ. Sci., 1: 11-21.
07. Rogers, S.B., 2011. Evaluation and testing of brick dust as a pozzolanic additive to lime mortars for architectural conservation. Masters Thesis, University of Pennsylvania, Philadelphia, Pennsylvania.
08. ASTM., 2015. Standard specification for Portland cement. ASTM C150/C150M, American Society for Testing and Materials, West Conshohocken, Pennsylvania.