European Journal of Business & Social Sciences
Available at https://ejbss.org/
ISSN: 2235-767X
Volume 07 Issue 10
July2019

A Study On Effect Of Limestone Powder As Cement Replacement On Concrete

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ABSTRACT

With increase in demand of concrete, more and more new methods and new materials are being developed for production of concrete. Making concrete is an art which has to be perfectly done, otherwise that will end up with bad concrete. The production of cement is an energy intensive process, resulting in emission of green house gases which adversely impact on the environment. At the same cost of production of cement is increasing at alarming rate and natural resources giving the raw material for its manufacturing are depleting.In this study, the scope of research will be focused on the partial replacement of cement using Limestone Powder Waste (LPW) material. In present investigation is mainly focused on the effect of mechanical properties on high strength concrete with lime stone powder replacement as supplement. In this investigation concrete having compressive strength M40with LPW as supplementary material.LPWis used to replace cement in the concrete with 0 to 40 % by weight of cement. A study will be to assess the effect of LPW on Modulus of Elasticity of high strength concrete.

INTRODUCTION:

The most important mechanical properties of concrete are compressive and flexural strength. The mechanical properties of concrete can be improved with alternative materials used for partial replacement of Portland cement in concrete. These materials are widely utilized around the world with the advent of new European Standards and are becoming more and more common due to some technical, economic and environmental reasons. One of these materials is diatomaceous rocks. Several large diatomaceous deposits have been discovered in **Afyonkarahisar.**Diatomite is a sedimentary rock of biogenic origin with high natural amorphous silica content. The amorphous silica (opal-A) is mainly in the form of diatom frustules, and secondarily in the form of sponge spicules, silicone–flagellate skeletons and/or radiolarian cells. This type of SiO2 can react with $Ca(OH)_2$ and produce calcium silicate hydrates (CSH), which are responsible for the development of strength. Beside opal-A, the diatomite rocks commonly contain carbonate and clay minerals, quartz, feldspars and volcanic glass. Utilization of SCMs such as fly ash from coal combustion, or silica fume from silicon and ferrosilicon alloy production, or blast furnace slag from pig iron production, as cement replacement represents a value-added approach to address the environmental concerns. As such, not only the energy consumption and carbon dioxide emission could be reduced during the cement manufacturing process, environmental advantages could also be obtained with respect to reduction in solid waste disposal and landfills.

Concrete mix design is the science of deciding relative proportions of ingredients of concrete, to achieve the desired properties in the most economical way. With advent of high-rise buildings and pre-stressed concrete, use of higher

ISSN: 2235-767X
Volume 07 Issue 10
July2019

grades of concrete is becoming more common. Even the revised IS 456–2000 advocates use of higher grade of concrete for more severe conditions of exposure, for durability considerations. Since structural concrete is used extensively in the construction of various kinds of buildings, consumed at a rate of approximately one ton for every living human being and aggregate contributessignificantly to the structural performance of concrete, the high demand for concrete using normal weight aggregates such as gravel and granite drastically reduces the natural stone resources and this damages the environment thereby causing ecological imbalance. Therefore, there is a need to explore and to find suitable replacement material to substitute the natural stone aggregate

Compared to those SCMs from industrial by-products, calcined clay is believed to have even greater potential to address the environmental impact of cement and concrete in the future, considering its availability on the earth. On the other hand, another form of SCM, glass powder, should not be ignored due to its silica rich nature and huge amount of disposal globally. It was estimated that the global disposed solidwastewas 200 million tons in 2004, 7% of which was glass products. In 2013, 11.54 million tons of lime powder was generated in United States and only 27.3% was reused.Lime powder were normally disposed into landfills if not recycled. Previous studies indicated the potential use of waste glass as constituent in concrete, such as in the form of aggregates, filler, alkali activated binder, and SCM. The latter could bring about more economical and sustainable impact to the society.

LITERATURE REVIEW:

Turhan investigated the utilization of the waste MD in self-compacting concrete (SCC), as filler material, is themain objective of this study. Besides, the MD is used directly without attempting any additional process. Thus, this would be another advantage for this objective. For this purpose, MD has replaced binder of SCCat certain contents of 0, 50, 100, 150, 200, 250 and 300 kg/m^3.The effect of waste MD usage as filler material on capillarity properties of SCC is also investigated. According to the test results, it is concluded that the workability of fresh SCC has not been affected up to 200 kg/m^3 MD content. However, the mechanical properties of hardened SCC have decreased by using MD, especially just above 200 kg/m^3 content. **Burak** investigated the usability of a quarry dust limestone powder in self-compacting paste and concrete applications was investigated. In the first part, the physical and mechanical properties of cement pastes incorporating quarry waste limestone powder (QLP) and a powder produced by direct grinding of

limestone (PLP) were compared. In the second part, the performance of quarry waste limestone powder in SCC applications were tested and discussed. Results showed that, it is possible to successfully utilise high amounts of quarry waste limestone powder in producing normal-strength SCCs. Among its observed mechanical advantages, employment of quarry waste limestone powders improved the economical feasibility of SCC production. **Kamile** dealt with the selection of amount and type of powders from the viewpoint of fresh state rheology and mechanical performance. The influence of powder materials on self-compactability, viscosity and strength were compared with a properly designed set of test methods (the mini slump, V-funnel tests, viscosity measurements and compressive strength tests). It may be advised that, for each cement–powder–plasticizer mixture, a series of test methods can be used to determine the optimum content and type of materials for a specified workability.

3.0 MATERIALS

3.1 Cement:

Ordinary Portland cement of 53 grade, conforming to IS: 12269-1999 with particle size of 90µ has been used in the present investigation. The specific gravity, standard consistency were 3.12 and 32% respectively.

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3.2 Fine Aggregates:

Locally available river sand conforming to Zone-II as per IS: 383-1999 has been used. The bulk density, specific gravity, and fineness modulus of the sand were 1.41g/cc, 2.68, and 2.9.

3.3 Coarse Aggregates:

Crushed granite aggregate of maximum 16 mm size conforming to IS: 383-1999 has been used. The bulk density, specific gravity and fineness modulus of the coarse aggregate were 1.46g/cc, 2.7 and 7.1.

3.4 Lime powder:

The specific gravity of lime stone powder was 2.86 with an average size 90µm.

3.5 Water:

Water plays a vital role in achieving the strength of concrete. For complete hydration it requires about 3/10th of its weight of water. It is practically proved that minimum water-cement ratio 0.35 is required for conventional concrete. Water participates in chemical reaction with cement and cement paste is formed and binds with coarse aggregate and fine aggregates. If more water is used, segregation and bleeding takes place, so that the concrete becomes weak, but most of the water will absorb by the fibers.

4.0 EXPERIMENTAL PROCEDURE

The investigation was aimed at studying the effect of LPW concrete on compressive strength, split tensile strength, flexural strength of M40 grade of concrete. Mix proportioning of concrete will be done based on guidelines of IS 10262: 2009. To study clear effect on early and later strength of concrete the specimens will be tested for 28 days. Standard cubes (150x150x150 mm), cylinders (150 mm diameter, 300 mm height), prisms (100x100x500 mm) will be cast to investigate the behaviour on mechanical properties and effect on modulus of elasticity. Slump and Compaction factor will be done to test the effect on workability of concrete due to LPW. The replacement of LPW will be varied from 0 to 40% with an increment of 10% i.e 0, 10%, 20%, 30% and 40% replacement to cement.

Table 1 - Mix Proportions of mixes M40 grade in kg/m^3

Cement	Fine Aggregate	Coarse Aggregate	Water
385	786	954	188

5. RESULTS AND DISCUSSION

5.1 Workability:

Workability test is performed on the fresh concrete by slump cone and compaction factor test. Slump cone test and compaction factor were conducted as per Indian standards as explained in previous chapter. The resu cone and compaction factor test for M40 grade of concrete with glass powder replacement to cement is shown in table 2.

Table 2: Effect of coconut on workability of M40 concrete

Lime powder Replacement (%)	Slump Cone (mm)	Compaction Factor
0	85	0.92
10	92	0.93
20	96	0.94
30	102	0.96
40	110	0.96

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Figure 3: Variation slump cone with glass powder replacement

5.2 Mechanical Properties:

Fresh properties of concrete like workability has performed using slump test. Slump is decreasing as the percentage of lime powder increases. Compression testing machine of 2000 kN used for the compression test and 600 kN UTM has been used for the split tensile test and flexural test. The results of compressive strength, split tensile strength and flexural strength are given in the Table 3.

Table 3: Effect of glass powder on mechanical properties of M40 concrete

Lime powder Replacement (%)	Compressive strength (MPa)	Split tensile strength (MPa)	Flexural Strength (MPa)
0	48.5	3.87	5.91
10	52.8	4.04	6.17
20	53.7	4.07	6.22
30	57.2	4.20	6.42
40	50.4	3.95	6.03

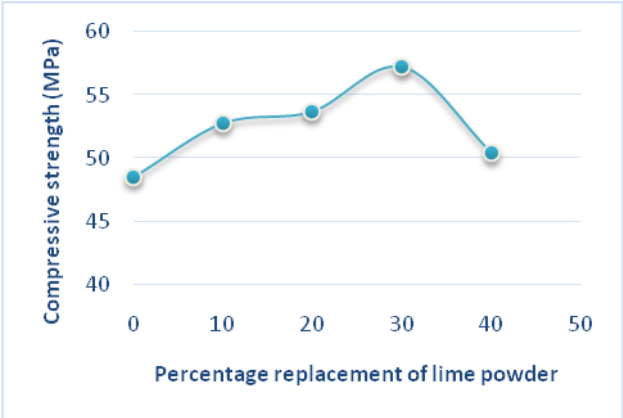


Figure 5: Variation compressive strength with lime powder replacement.

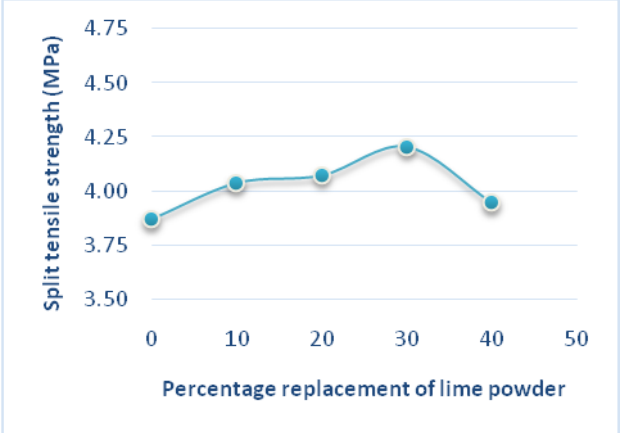


Figure 6: Variation split tensile strength with lime powder replacement

ISSN: 2235-767X
Volume 07 Issue 10
July2019

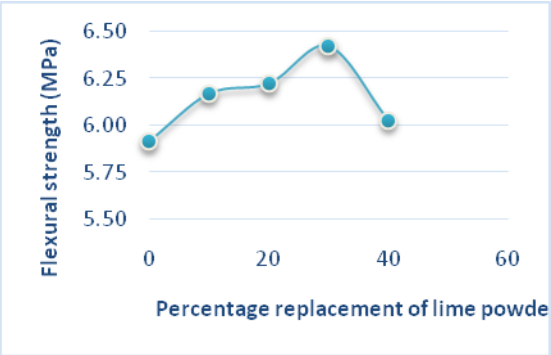


Figure 7: Variation flexural strength with lime powder replacement

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6.0 CONCLUSIONS

1. The workability of concrete is effected with the lime powder replacement to natural coarse aggregate.
2. The increased in slump and compaction factor is observed with the increase in replacement levels of lime powder.
3. Lime powder replacementinto concrete has effected the mechanical properties of concrete.
4. Upto 40% replacement levels of lime powder is effect in decrease in mechanical properties is limited to 30% only.
5. Similarly, the adverse decrease in mechanical properties is observed with the increase in replacement of lime powder to 30%.
6. It is concluded that lime powder can be used as replacement to OPC to produce efficient sustainable concrete.
7. Finally, optimum replacement of lime powder was observed to be 30% without much loss in fresh and hardened properties.

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European Journal of Business & Social Sciences
Available at https://ejbss.org/

ISSN: 2235-767X
Volume 07 Issue 10
July2019