Study on Behaviour of Concrete by Replacing of Cement by Lime Stone Powder

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Abstract

The reduction of using cement content in concrete is one of the resolute global sustainability concerns of the 21st century. of all the ingredients in concrete (the primary ones being cement, supplementary cementitious materials, water, and coarse and fine aggregates), cement has the largest footprints when it comes to both carbon dioxide release and energy consumption.the material that has been used in concrete in some parts of the world for many years, but is receiving renewed interest globally, is limestone powder, typically available in the form of the calcite polymorph of calcium carbonate and with varying percentages of magnesium (carbonate). The source for cement production is calcium which is a product of lime stone , as well as being one of the most commonly employed aggregates, its presence is ubiquitous within the concrete industry. In this study we approached to know the behaviour of concrete by adding lime stone powder as a replacement of cement from 0 to 15% and conducted tests on concrete in fresh and hardened state.

Key Words: *Lime Stone Powder, Slump, Compressive Strength*,

Introduction

The reduction of cement content in concrete is one of the persistent resolute sustainability concerns of the 21st century. Of all the ingredients in concrete (the primary ones being cement, supplementary cementious materials, water, and coarse and fine aggregates), cement has the largest footprints when it comes to both carbon dioxide release and energy consumption. The material that has been used in cement concrete in few parts of the world for many years, but is receiving renewed interest globally, is limestone powder, typically available in the form of the calcite polymorph of calcium carbonate and with varying percentages of magnesium (carbonate). The important source of calcium for production of cement is limestone, as well as being one of the most commonly employed aggregates, its presence is ubiquitous within the concrete industry. Limestone powder can also physically improve the denseness of hardened Portland cement paste due to its filling effect. The optimum use of limestone powder as a supplementary material to Portland cement has therefore technical benefits, such as improved workability, bleeding control, lower sensibility to the lack of curing, and a little bit increased early strengths. On the

other hand, loss of strength at later ages due to incorporation of limestone has also been reported.

Literature Review

Wendimu Gudissa etal. (2010) The investigation has revealed that, Replacement of ordinary Portland cement by fine limestone powder from 5% to 10% with Blain fineness value of 4000 to 4500 cm^2/gm satisfies the standard compressive strength requirement of high early strength cement as per the standard requirements. The results of grinding shows that, as the replacement of limestone increases by weight, increases in cement fineness and decrease in grinding time were observed compared to pure ordinary Portland cement. Since limestone is softer to grind than pure clinkers the energy required is also relatively less than required to grind pure clinker for Portland cement production. The test results indicated that, the compressive and flexural strengths of cement mortar decrease with the increase in the percentage addition of limestone content for same blain fineness and also increase with the increase of fineness

Didier Lootens etal In this study the information about acceleration of early-age hydration and reduction in setting time by using both limestone and silica has been demonstrated. When limestone powder used as partial replacements for cement, these fillers provide sufficient surfaces to serve as templates for the growth of cement hydration products and their relatively provides setting, rigidity, and strength to these materials. The precipitation-friendly surfaces of the fillers reduce the amount of hydration product precipitation occurring initially on the cement particles, so that the renewed reactivity of (unexposed) aluminates, etc., typically observed as a second heat flow peak or a shoulder on the primary hydration peak, is improved, especially at cement replacement levels of 80 % and above. The hydration of lime stone powder is higher than the silica on a per unit surface area basis, it provides further benefits in rheological properties by reducing the yield stress and lowering the consistency factor, when used to replace cement on a one-to-one volume basis. Due to their acceleration hydration of cement, replacement levels of up to 40 % of these fillers for cement have minimal impact on initial setting times, suggesting that these sustainable binary blends may be particularly attractive in applications where controlled setting is more important than development of high strengths, such as mortar tile adhesives, other grouts, and renderings for building facades.

Tarun R. Naik etal. This study gives the information about increase of effective *w/c*, accelerate early-age strength, dilution of cement paste and cement concrete mix effects

the rate of hydration by using the limestone powder filler in cement. The addition of limestone powder filler to fine cement pastes and mortars reduces the diffusion coefficient of chloride ions. Using limestone powder in concrete proves economic and environmental advantages by reducing the usage of Portland cement in constructions and CO2 emission, as well as improving the early and the later age compressive strength. Limestone powder to cement changes the phase composition of pastes in comparison with pastes without addition. They also showed limestone powder prevents the transformation of ettringite to sulphoaluminates (monosulphate, hemisulphate and solid solutions), instead of which carboaluminate phases more resistant to sulphate attack (monocarbonate, hemicarbonate) are formed.

Materials and Methodology

The physical properties of materials per performed as per IS standards. The mix design is performed as per IS 10262-2009. Then the cubes and cylinders are casted by varying the percentage of lime stone powder as a binding material in concrete mix varies from 0, 5, 10 & 15%. Tests performed on fresh and hardened concrete. The specimens were weighed after curing of 7, 14 & 28 days to know the significance changes in density before testing compressive strength.

Table.1 **Chemical Composition of lime stone powder**

Component	**Lime stone powder (%)**
Sio_2	11.25
Al_2O_3	2.76
Fe_2O_3	1.15
CaO	43.77
SO_3	0.27
MgO	2.15
Na_2O	0.35

Table.2 **Physical Properties of materials**

SI no.	**Material**	**Results**
1.	Specific Gravity	3.15
2.	Compressive strength(N/mm^2)	54
3.	Specific gravity of fine aggregate	2.53
4.	Water absorption of Coarse agregate	0.5%
5.	Specific Gravity of Coarse aggregate	2.72
6	Specific Gravity of Lime stone Powder	2.48

Table.3Slump value for different mix with water cement ratio of 0.4

Sl No.	**% of limestone powder added**	**Slump(mm)**
1.	0	110
2.	5	60
3.	10	50
4.	15	45

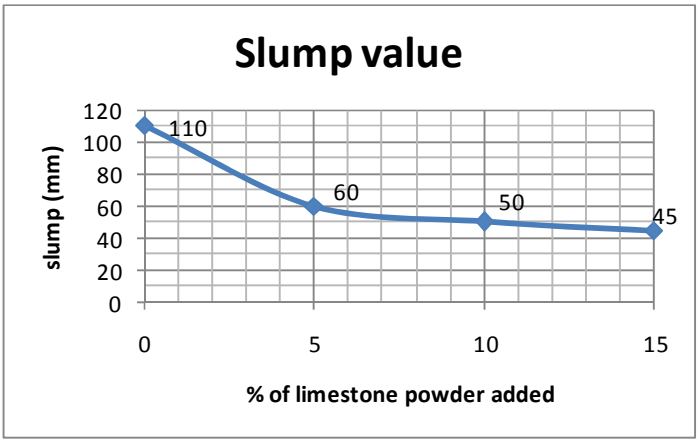

Figure.1 Slump value for different % of limestone powder

Tale.4 Density of concrete

% of limestone powder added	Density (kg/m^3)
0	2506.6
5	2488.8
10	2471.1
15	2444.4

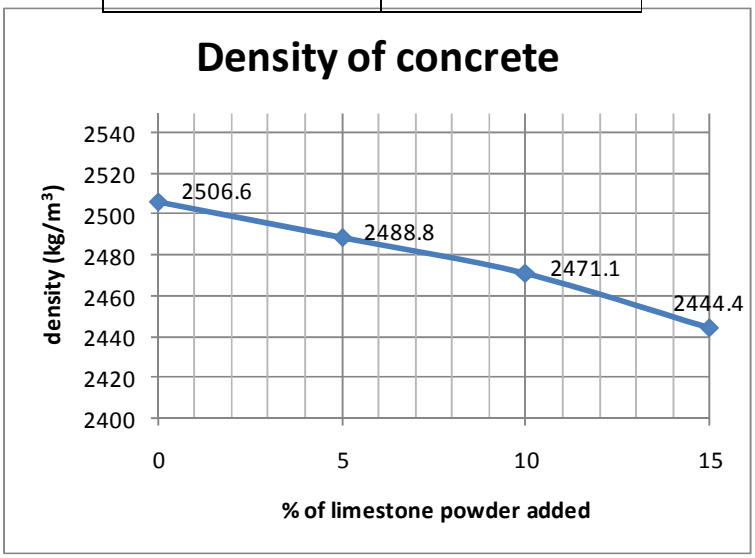

Figure.2 Density of concrete mix v/s Percentage of limestone powder

Table.5 Compressive strength

SL No.	% of limestone powder	Average compressive strength (Mpa)		
		7 days	14 days	28 days
1.	0	45.23	53.01	62.96
2.	5	46.6	50.7	60.8
3.	10	42.77	48.63	55.31
4.	15	31.2	35.4	39.5

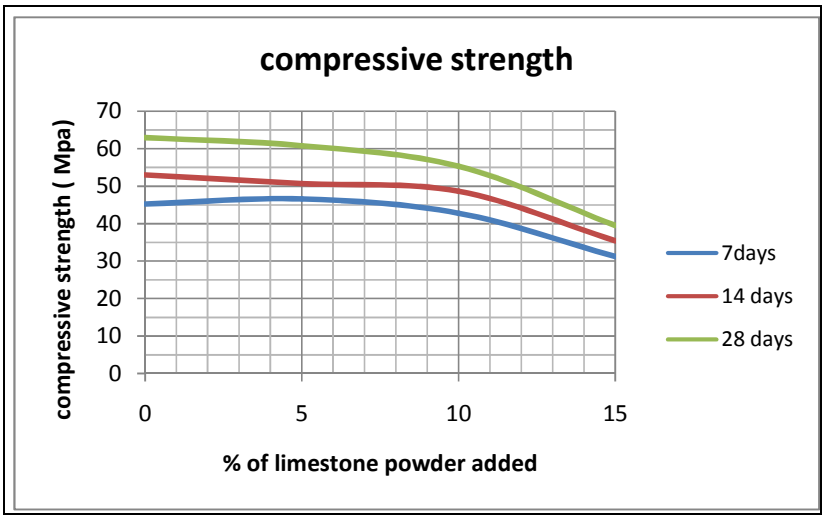

Figure.3 Compressive strength v/s Percentage of limestone powder

Table.6 Tensile Strength

SL No.	% of limestone powder added	Tensile Strength(Mpa)	
		7days	28 days
1.	0	3.182	5.14
2.	10	2.9	5.04
3.	15	2.74	4.14

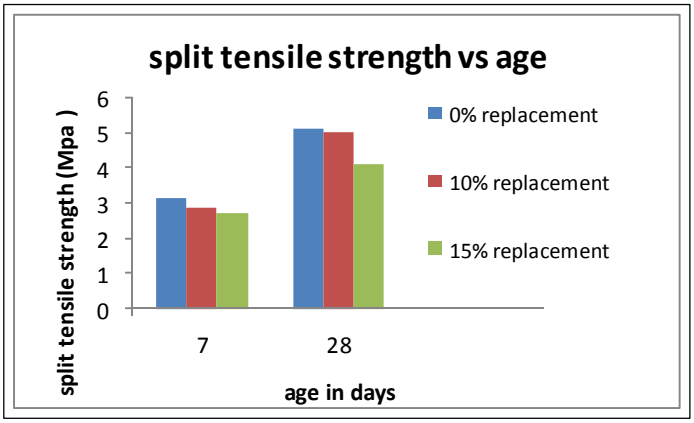

Figure.4 Split Tensile v/s Percentage of limestone powder

Conclusion

The following conclusions can be drawn from the obtained experimental data:

Maximum 10% of cement can be replaced by limestone powder without change in the strength of the concrete. Required split tensile strength can be achieved by 10% replacement of cement by limestone powder. The addition of limestone filler in to Portland cement results in increase in cement fineness and this fineness of the cement provide higher rate of hydration and hence faster development of the early strength. The use of limestone powder in cement and concrete provides economic and environmental advantages by reducing Portland cement production and CO2 emission. From the standard consistency results, it seems that limestone has no effect on water requirement compared to Portland cement. Moreover, the increase in level of fine particles caused requires much water.

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