

Analysis the Effect of Steel Fibre and Marble Dust with Strength of Pavement Quality Concrete

Krishan Kumar

MTEch Scholar - Department of Civil Engineering
Om Institutes of Technology & Management,
Juglan Hisar (Haryana)

Sumesh Jain

Asst Professor, Department of Civil Engineering Om
Institutes of Technology & Management,
Juglan Hisar (Haryana)

ABSTRACT

The thrust nowadays is to produce thinner and green pavement sections of better quality, which can carry the heavy loads. The high strength steel fibre reinforced concrete is a concrete having compressive strength greater than 40MPa, made of hydraulic cements and containing fine and coarse aggregates; and discontinuous, unconnected, randomly distributed steel fibres. The present study aims at, developing pavement quality concrete mixtures incorporating marble dust as partial replacement of cement as well as steel fibres. The aim is to the design of slab thickness of PQC pavement using the achieved flexural strength of the concrete mixtures. In this study, the flexural, compressive and split tensile strength for pavement quality concrete mixtures for different percentage of steel fibres and replacement of cement with marble dust are reported. It is found out the maximum increase in flexure strength, compressive strength and split tensile strength is for 0% Marble Dust and 1% Steel fibre. Also it has been possible to achieve savings in cement by replacing it with marble dust and adding fibres. This study also shows that in view of the high flexural strength, high values of compressive strength and high values of split tensile strength, higher load carrying capacity and higher life expectancy, the combination of 10 to 20% marble dust replacement along with addition of 0.5 to 1% steel fibres is ideal for design of Pavement Quality Concrete (PQC).

I INTRODUCTION

The aggregate is generally coarse gravel or crushed rocks as limestone, or granite, along with a fine aggregate such as sand. The cement, commonly Portland cement and other cementations materials such as fly ash and slag cement serve as a binder for the aggregate. Various chemical admixtures are also

added to achieve varied properties. Water is then mixed with this dry composite which enables it to be shaped (typically poured) and then solidified and hardened into rock-hard strength through a chemical process known as hydration. The water reacts with the cement which bonds the other components together, eventually creating a robust stone like material. Concrete has relatively high compressive strength. For this reason is usually reinforced with materials that are strong in tension (often steel). Concrete can be damaged by many processes, such as the freezing of trapped water. The environmental impact of concrete is a complex mixture of not entirely negative effects; while concrete is a major contributor to greenhouse gas emissions, recycling of concrete is increasingly common in structures that have reached the end of their life. Structures made of concrete can have a long service life. As concrete has a high thermal mass and very low permeability, it can make for energy efficient housing. As we know Concrete is a versatile construction material. Firstly it was innovated as protective cover of steel members, after that it was revised and now a day's concrete is used as a structural member and steel is provided to modify its properties and give better strength to the concrete. Concrete has benefits like fire resistance, excellent resistance to water, has ability to mould into various shapes and sizes easily as per requirement, economic and readily available material on the job site. It was observed that the normal concrete have many inadequacy such as low value of strength to weight ratio as compared to steel. So as to overcome this inadequacy resulted in the development of high strength concrete (HSC).

II MATERIAL AND DESIGN Properties of Coarse Aggregates METHODOLOGY

Portland Cement It constitutes only about 20 percent of the total volume of concrete mix; it is the active portion of binding medium and is the only scientifically controlled ingredient of concrete. Any variation in its quantity affects the compressive strength of the concrete mix. Portland cement referred as (Ordinary Portland Cement) is the most important type of cement and is a fine powder produced by grinding Portland cement clinker. The OPC is classified into three grades, namely 33 Grade, 43 Grade, 53 Grade depending upon the strength of 28 days.

Aggregate

Aggregates constitute the bulk of a concrete mixture and give dimensional stability to concrete. To increase the density of resulting mix, the aggregates are frequently used in two or more sizes. The most important function of the fine aggregate is to assist in producing workability and uniformity in mixture. The fine aggregate assist the cement paste to hold the coarse aggregate particles in suspension. This action promotes plasticity in the mixture and prevents the possible segregation of paste and coarse aggregate, particularly when it is necessary to transport the concrete some distance from the mixing plant to placement. The aggregates provide about 75% of the body of the concrete and hence its influence is extremely important. They should therefore meet certain requirements if the concrete is to be workable, strong, durable and economical. The aggregates must be proper shape, clean, hard, strong and well graded.

a) Coarse Aggregates: The aggregate which is retained over IS Sieve 4.75 mm is termed as coarse aggregate. The coarse aggregates may be of following types:-

- i) Crushed gravel or stone obtained by crushing of gravel or hard stone.
- ii) Uncrushed gravel or stone resulting from the natural disintegration of rocks.
- iii) Partially crushed gravel or stone obtained as product of blending of above two types.

Characteristics	Value
Colour	Grey
Shape	Angular
Maximum Size	20 mm/10mm
Specific Gravity	2.73/2.72
Water Absorption	0.20%/0.35%

b) Fine Aggregates: The aggregates most of which pass through 4.75 mm IS sieve are termed as fine aggregates. The fine aggregate may be of following types:

- i) Natural sand, i.e. the fine aggregate resulting from natural disintegration of rocks.
- ii) Crushed stone sand, i.e. the fine aggregate produced by crushing hard stone.
- iii) Crushed gravel sand, i.e. the fine aggregate produced by crushing natural gravel.

According to size, the fine aggregate may be described as coarse, medium and fine sands. Depending upon the particle size distribution IS: 383-1970 has divided the fine aggregate into four grading zones.

c) Marble Dust

Marble dust was collected from different site. It was white in colour and it was air dried and powder in form.

d) Steel Fibre

Mild steel fibres having 30 mm thickness and 60 mm length i.e. aspect ratio (l/d) 50 which are corrugated and obtained through cutting of steel wires have been used. The fibres have been cut

SUPERPLASTICIZER

Super-plasticizers constitute a relatively new category and improved version of plasticizer. They are chemically different from normal plasticizers. Use of super-plasticizer permits the reduction of water to the extent up to 30 percent without reducing workability in contrast to possible reduction up to 15 percent in case of plasticizers. The mechanism of action of super-plasticizer is more or less same as in case of ordinary plasticizer. The super-plasticizers are more powerful as dispersing agents and they are high water reducers. It is use of super-plasticizer which has made

it possible to use w/c as low as 0.25 or even lower and yet to make flowing concrete to obtain compressive strength of the order of 120 MPa or more (Shetty 2005). It is the use of super-plasticizer which has made it possible to use fly ash, slag and particularly silica fume to make high performance concrete.

WATER

The potable water is generally considered satisfactory for mixing and curing of concrete. Accordingly potable water was used for making concrete available in Material Testing laboratory. This was free from any detrimental contaminants and was good potable quality.

TEST METHODS

1. Specific Gravity
2. Sieve Analysis for Coarse and Fine Aggregates
3. Compressive Strength of Concrete
4. Split Tensile Strength of Concrete

Result

**Effect on compressive strength:
Test Results of Compressive Strength vs. W/C Ratio**

Compressive strength		W/C = 0.3
Sample ID	Percentage decrease in compressive strength	Percentage increase in compressive strength
10% M.D / 0% S.F	-7.08%	
20% M.D / 0% S.F	-53.56%	
0% M.D / 0.5% S.F		11.97%
10% M.D / 0.5% S.F		5.05%
20% M.D / 0.5% S.F	-5.47%	
0% M.D / 1% S.F		78.70%
10% M.D / 1% S.F		63.30%
20% M.D / 1% S.F		38.60%

**b) Effect on split tensile strength:
Test Results of Split Tensile Strength vs. W/C Ratio**

Compressive strength		W/C = 0.30
Sample ID	Percentage decrease in compressive strength	Percentage increase in compressive strength
10% M.D / 0% S.F	-3.74%	
20% M.D / 0% S.F	-31.86%	
0% M.D / 0.5% S.F		5.82%
10% M.D / 0.5% S.F		5.82%
20% M.D / 0.5% S.F	-2.77%	
0% M.D / 1% S.F		53.74%
10% M.D / 1% S.F		42.66%
20% M.D / 1% S.F		17.73%

**c) Effect on flexural strength:
Test Results of Flexure Strength vs. W/C Ratio**

Compressive strength		W/C = 0.30
Sample ID	Percentage decrease in compressive strength	Percentage increase in compressive strength
10% M.D / 0% S.F	-3.44%	
20% M.D / 0% S.F	-10.66%	
0% M.D / 0.5% S.F		0.66%
10% M.D / 0.5% S.F		3.28%
20% M.D / 0.5% S.F	-3.93%	
0% M.D / 1% S.F		19.18%
10% M.D / 1% S.F		10.33%
20% M.D / 1% S.F		0.65%

CONCLUSIONS

From the experimental results, the following conclusion can be drawn:

Strength Characteristics

➤ Concrete mix with 10 percent marble dust as replacement of cement is the optimum level as it has been observed to show a significant increase in compressive strength at 28 days when compared with nominal mix.

➤ Concrete mixes when reinforced with steel fibre show an increased compressive strength as compared to nominal mix.

➤ The split tensile strength also tends to increase with increase percentages of steel fibres in the mix.

➤ On increasing the percentage replacement of cement with marble dust beyond 10%, there is a slight reduction in the tensile strength value.

➤ The flexure strength also tends to increase with the increase percentages of steel fibres, a trend similar to increase in split tensile strength and compressive strength.

➤ On increasing the percentage replacement of cement with marble dust beyond 10%, there is decrease in the flexure strength value.

Maximum strength (flexure, compressive as well as split tensile) of pavement quality concrete incorporating marble dust and steel fibres, both, is achieved for 10% marble dust replacement and 1% steel fibres. However, if the marble dust content is increased to 20%, even with 1% steel fibre, the increase is not very significant.

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