International Journal of Engineering and Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org ||Volume 15 Issue 7 July 2026 || PP 05-08

Development And Optimization of M30 SCC Mix Using Indian Standard Code 10262; 2019

O.Ankamma Raju[1], Dr T V S Vara Lakshmi[2]
[1]*(Civil Engineering, University College of Engineering And Technology/ Acharya Nagarjuna University, India)*
[2]*(Civil Engineering, University College of Engineering And Technology/ Acharya Nagarjuna University, India)*

ABSTRACT: *Self-Compacting Concrete (SCC) is a high-performance concrete that flows under its own weight without vibration. This study focuses on designing M30 grade SCC using Indian standard code IS 10262:2019 guidelines. The mix was optimized for slump flow, V-funnel time, and passing ability. A balanced water-to-powder ratio and super plasticizer dosage ensured high flow ability and stability. The mix achieved Fresh and hardened properties were within acceptable limits. The study confirms the suitability of M30 SCC for structural applications*

KEYWORDS - *Self-Compacting Concrete (SCC), M30 Grade, Mix Design, Slump Flow, V-Funnel, Super plasticizer, Flow ability, Workability*

Date of Submission: 08-07-2026 Date of acceptance: 20-07-2026

I.INTRODUCTION

Concrete is the most widely used construction material in the world due to its versatility, durability, and affordability. Among various types of concrete, Self-Compacting Concrete (SCC) has emerged as a revolutionary innovation that eliminates the need for mechanical vibration during placement. It flows under its own weight, achieving excellent compaction and surface finish even in complex formwork or heavily reinforced sections. SCC ensures improved constructability, reduced labor cost, and enhanced durability due to minimal voids and honeycombing.SCC was first developed in Japan during the late 1980s to address quality and workmanship issues in concrete construction. Since then, its adoption has grown globally, particularly in high-rise buildings, bridges, precast elements, and areas with dense reinforcement. The design of SCC requires careful control of mix proportions, especially fine particles and super plasticizers, to achieve the desired rheological properties such as high flow ability, low segregation, and adequate viscosity. At the same time, the cement industry is under growing pressure to reduce its environmental footprint. The production of Ordinary Portland Cement (OPC) is highly energy-intensive and emits a significant amount of carbon dioxide (CO_2), contributing to global warming. In response, researchers and engineers are increasingly seeking supplementary cementitious materials (SCMs) and industrial by-products that can partially replace cement without compromising concrete performance. Marble Waste Powder (MWP) is one such promising material. Generated as a by-product during the cutting, grinding, and polishing of marble blocks, marble waste is often dumped in landfills or open areas, leading to environmental pollution, dust hazards, and land degradation. MWP is mainly composed of calcium carbonate ($CaCO_3$), which has a fine particle size and Pozzolanic or filler potential in cementitious systems. The use of MWP in SCC offers a twofold advantage: it reduces the consumption of OPC (thus lowering CO_2 emissions and production costs), and it provides an effective solution for marble waste disposal. Moreover, the fines particles of MWP help fill voids between cement and aggregates, improving the packing density and cohesiveness of the concrete mix. This is particularly beneficial in SCC, which relies on high powder content and enhanced flow properties. Designing M30 grade SCC with MWP as a partial cement replacement is particularly relevant for structural applications where moderate strength and high workability are required. However, the influence of MWP on strength development, setting time, workability, segregation resistance, and long-term durability must be systematically evaluated.

II.LITERATURE REVIEW

Aliabdo et al. (2014) conducted a comprehensive experimental study on the use of marble powder in self-compacting concrete. The results demonstrated that MWP could replace cement up to 15% by weight without compromising compressive strength. The addition improved workability due to the filler effect, and the optimized mix showed improved durability indicators.Uysal and Yilmaz et al,.(2011) explored the influence of mineral admixtures, including MWP, in SCC. Their findings indicated that SCC with MWP up to 20%

maintained the required workability and strength, meeting the EFNARC guidelines. They also noted improved resistance to segregation and bleeding.Gencel et al. (2012) assessed the properties of SCC containing marble dust as partial cement and sand replacement. The study highlighted that MWP improves packing density and enhances the cohesion of the concrete mix. The finer particles of marble dust helped reduce the w/b ratio while maintaining workability.Hebhoub et al. (2011) investigated concrete mixes with marble waste as cement replacement and found that up to 10% replacement could be done without adversely affecting the strength. Marble waste acted as an inert filler and contributed to better micro structural integrity.Modani and Vyawahare et al, (2013) focused on the behavior of SCC with varying percentages of marble powder. The researchers observed that MWP reduced water absorption and increased compressive strength at later ages, attributing the improvement to better particle packing and possible secondary hydration reactions.Singh et al. (2016) explored the use of different industrial wastes in SCC and concluded that marble dust could be effectively used up to 20% as cement replacement. They emphasized the environmental and economic benefits alongside satisfactory mechanical performance.Mishra and Pandey (2017) evaluated the use of MWP in SCC and found improved performance in terms of flowability and filling ability. The study also noted a slight delay in setting time, which was within acceptable limits.Talah et al. (2019) observed that incorporating marble powder enhances the resistance of SCC to sulfate attack, likely due to the reduction in permeability and improved microstructure.Bheel et al. (2021) noted that the durability characteristics, including resistance to chloride penetration and drying shrinkage, improved in mixes with MWP. Their study also confirmed the reduction in heat of hydration when marble powder was used.Ghorpade and Chitlange (2014) analyzed SCC with mineral admixtures and found that MWP positively influences flow ability, while the optimal replacement level was around 15% for M30 grade concrete. Most literature agrees on the optimal replacement level of MWP between 10% and 20%, depending on mix composition and performance goals. It is evident that MWP primarily acts as a filler material but may also exhibit minor Pozzolanic behavior due to its fine particle size and high calcium content. The key benefits of using MWP in SCC include:

- Improved flow characteristics due to better particle distribution,
- Reduced segregation and bleeding,
- Enhanced surface finish and homogeneity,
- Potential for reduced heat of hydration,

Lower environmental impact through waste utilization and reduced cement demand

III.MIX DESIGN

- Grade Designation = M30
- Type of cement used = OPC 53 grade confirming to IS 269
- Maximum nominal size of aggregate = 12.5 mm
- Exposure Condition as per Table 3 & Table 5 of IS 456(Severe):2002
- Characteristics ‘of SCC
  - Slump flow class: SF3 (slump flow 760 mm – 850 mm)
  - Passing ability by L box test: Ratio of h2 /h1 = 0.9
  - V- Funnel flow time (Viscosity): Class V1 (flow time $\leq$ 8s)
  - Sieve segregation resistance: SR1 (<15percent)
- Degree of Site Control=Good
- Type of aggregate = Crushing angular aggregate
- Maximum cement content = 450 kg/m^3
- Chemical Admixture= PCE Type
- Mineral Admixture=(Marble Waste Powder)
- Specific gravity of cement = 3.15
- Specific gravity of F.A = 2.63
- Specific gravity of C.A = 2.74

Step 1: Target Strength for Mix Proportioning

$$F^{1\prime}_{ck} = f_{ck} + 1.65S$$

or

$$f'_{ck} = f_{ck} + X$$

Where

F ’ck=target mean compressive strength 28days,

f_{ck} = characteristic compressive strength at 28 days,

S = standard deviation, and

X=factor based on grade of concrete.

From IS10262:2019, Table-1, Pg.No:3, X= 6.5N/mm^2

From IS10262:2019, Table-2, Pg.No3,S=5.0N/mm^2

$$f'ck = f_{ck} + 1.65S = 30 + 1.65(5.0) = 38.25 N/mm^2$$

$$f'ck = f_{ck} + X = 30 + 6.5 = 36.5 N/mm^2$$

The higher value is adopted.

Therefore, Target Strength will be 38.25 N/mm^2

Step 2: Approximate Air Content

x=1.5-((12.5-10)(1.5-1.0))/(20-10)

x=1.37

Step 3: Selection of water content

From Fig. 1, the free water-cement ratio required for the target strength of 38.25 N/mm^2 is 0.48 for OPC 53 grade curve. Prescribed for 'severe' exposure for reinforced concrete as per Table 5 of IS 456.

Hence: W/b Ratio = 0.48

Step 4: Selection of Water Content and cement content

Water-binder ratio= 0.48

Water Content=190 kg/m^3

Cement Content=Water content/Water-Cement ratio

= 190/0.48

= 395.8 kg/m^3>300 kg/m^3

The class of slump flow is specified to be SF3 having a slump flow between 750 and 850 mm. To start with, a water content of 190 kg/m^3 along with a super plasticizer @ 0.6 percent by mass of cementitious material content is selected for the initial mix. However, the water content can be reduced further by increasing the dose of super plasticizer. This water content of 190 kg/m3 will correspond to a cement content of 395.8 kg/m^3 for water cement ratio of 0.48.

Step 5: Selection of Admixture content

Taking an admixture dose of 0.6 percent by mass of cementitious material,

The mass of admixture = (0.6/100) × 395.8= 2.37 kg/m^3

Step 6: Selection of Powder Content and Fine Aggregate Content

The powder content (fines < 0.125 mm) required for SCC is generally in the range of 400 to 600 kg/m^3. Since, the SR of class 1 and viscosity of V1 is required; the mix shall be sufficiently cohesive, (having enough fines). Therefore a powder content of 500 kg/m^3 is selected. This powder content will constitute the entire OPC, entire Marble Waste Powder, and around 10 percent of Zone II fine aggregates.

Fines required to be contributed by fine aggregate = Total powder content – (MWP content + cement content) =500 – (316.8+79.2) = 84.2 kg/m^3

The fine aggregate has 8 percent materials < 0.125 mm (see clause 8.1 in IS 10262;2019).

Therefore, the fine aggregate quantity = 84.2/0.08 = 1052.5kg/m^3

Step 7: Selection of Coarse Aggregate Content

Let Vca be the volume of coarse aggregate.

Assuming 1 m^3 of concrete, Vca = (1 - Air content) - (Vol of water + Vol of cement + Vol of Mwp + Vol of admixture + Volume of fine aggregate)

Vca = (1- 0.013) – (((190)/(1*1000))+((316.8)/(3.15*1000))+((79.2/(2.63*1000))+((2.37)/(1.06*1000))+((1052.5)/(2.65*1000)))

= 0.266 m^3

Mass of coarse aggregate = Vca x specific gravity of coarse aggregate × 1000 = 0.26 × 2.74 × 1 000 = 731.3 kg/m^3

Step 8: Calculation of Volume of Powder Content

Vol of powder content = Vol of OPC + Vol of fly ash + Vol of portion of fine aggregate < 0.125 mm

=((316.8)/(3.15*1000))+((79.2)/(2.63*1000))+((84.2)/(2.65*1000))) = 0.176

Ratio of water to powder by volume = 0.190/ 0.176 = 1.07

NOTE — The water to powder ratio is expected to be between 0.85 and 1.10. In this case, it is ok. If water to powder ratio is found to be less than 0.85, then the fine aggregate content shall be reduced to increase the ratio; if the ratio is more than 1.1, then the fine aggregate content shall be increased to decrease the ratio. In such cases, all the values shall be recalculated.

MIX PROPORTIONS

- Cement+MWP =395.8 kg/m^3
- Water (net mixing) = 190 kg/m^3
- Fine aggregate (SSD) = 1052.5 kg/m^3
- Coarse aggregate (SSD) = 731.3kg/m^3
- Chemical admixture = 2.37 kg/m^3 ,
- Free water-Binder ratio = 0.48
- Powder content = 500 kg/m^3
- Water powder ratio by volume = 1.07

IV.CONCLUSION

The M30 grade SCC mix designed using IS 10262:2019 guidelines met workability requirements. The mix achieved excellent flow characteristics..Proper adjustment of water-to-powder ratio and super plasticizer dosage was crucial for performance. The study confirms the suitability of this mix for structural applications. IS 10262 can be effectively adapted for SCC with proper testing and optimization.

ACKNOWLEDGEMENTS

The authors greatly acknowledge the full-fledged support by the Acharya Nagarjuna University College of Engineering and Technology Acharya Nagarjuna University, Guntur Andhra Pradesh, India. The complete literature works were carried out in the laboratory of the Civil Engineering Department, Acharya Nagarjuna University. The great support of the University Management Team and Researchers were extremely acknowledged here with thank fullness.

REFERENCES

[1] Aliabdo, A. A., Elmoaty, A. E. M. A., & Auda, E. M. (2014). Re-use of waste marble dust in the production of cement and concrete. Construction and Building Materials, 50, 28–41. https://doi.org/10.1016/j.conbuildmat.2013.09.005

[2] Bheel, N., Jamali, A., Ali, N., Ali, I., & Memon, S. A. (2021). Effects of marble powder and granules on mechanical and durability properties of concrete – A review. Journal of Building Engineering, 35, 101742. https://doi.org/10.1016/j.jobe.2020.101742

[3] Gencel, O., Kocabas, A., Güneyisi, E., & Sahin, G. (2012). Properties of self-compacting concrete with marble waste aggregate. Materials and Design, 33, 498–504. https://doi.org/10.1016/j.matdes.2011.04.035

[4] Ghorpade, V. G., & Chitlange, M. R. (2014). Influence of marble powder/concrete waste on self-compacting concrete. International Journal of Civil and Structural Engineering, 4(2), 218–228. https://doi.org/10.6088/ijcser.2014040206

[5] Hebhoub, H., Aoun, H., Belachia, M., Houari, H., & Ghorbel, E. (2011). Use of waste marble aggregates in concrete. Construction and Building Materials, 25(3), 1167–1171. https://doi.org/10.1016/j.conbuildmat.2010.09.037

[6] Mishra, A., & Pandey, M. (2017). Study of self-compacting concrete using marble powder. International Journal of Civil Engineering and Technology (IJCIET), 8(1), 435–442.

[7] Modani, P. O., & Vyawahare, M. R. (2013). Utilization of waste marble powder in cement concrete. International Journal of Engineering Research and Applications (IJERA), 3(5), 656–661.

[8] Moura, W. A., Lima, M. B., & Bittencourt, B. O. (2007). Influence of marble waste as partial replacement of cement in concrete. Revista IBRACON de Estruturas e Materiais, 5(6), 778–793.

[9] Singh, M., Siddique, R., & Jain, K. (2016). Strength and permeability of self-compacting concrete incorporating industrial by-products. Construction and Building Materials, 103, 15–23. https://doi.org/10.1016/j.conbuildmat.2015.11.006

[10] Talah, A., Mouli, M., & Bouziani, T. (2019). Durability of self-compacting concrete containing marble dust. Journal of Materials and Environmental Science, 10(1), 42–51.

[11] Uysal, M., & Yilmaz, K. (2011). Effect of mineral admixtures on properties of self-compacting concrete. Cement and Concrete Composites, 33(7), 771–776. https://doi.org/10.1016/j.cemconcomp.2011.04.005

[12] Siddique, R., & Khan, M. I. (2011). Supplementary Cementing Materials. Springer. https://doi.org/10.1007/978-3-642-17866-5

[13] Singh, S., & Nagar, R. (2020). Sustainable utilization of marble slurry in self-compacting concrete: Performance and environmental assessment. Cleaner Materials, 2, 100027. https://doi.org/10.1016/j.clema.2020.100027

[14] Elmagd, A. A., El-Sayed, H. A., & Seleem, M. A. (2015). Mechanical properties and microstructure of self-compacting concrete incorporating marble waste. HBRC Journal, 11(3), 328–337. https://doi.org/10.1016/j.hbrcj.2014.11.001

[15] Gutiérrez, R. M., & Canovas, M. F. (1995). Waste materials in concrete technology: Sustainability and durability. CANMET/ACI International Symposium on Sustainable Development and Concrete Technology, 111–120.