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RHEOLOGY PROPERTY OF 3D PRINTED CEMENTITIOUS COMPOSITES MATERIALS INCORPORATING SHORT FIBERS -A REVIEW

Harshveer Singh Kachhwaha [1] , Mahipal Burdak[2] , Puneet Gaur [3]

[1]Project Consultant, NS Enterprise Jodhpur

[2]Sr General Manager (Technical Services & Marketing), Welspun Corp Ltd

[3] Guest faculty, Structural Engineering Department, MBM University Jodhpur

Abstract : Additive Manufacturing, also known as 3D Printing, is one of the various manufacturing technologies used in the domain of Rapid Prototyping. It has received increasing attention in many fields, such as building and construction, due to the benefits such as greater flexibility in constructing geometrically complex structures, massively improved efficiency, lowered onsite labour requirements, and less waste generated when compared to conventional manufacturing technologies. Due to its unique mechanical qualities, cementitious composites with short fibres have a lot of potential for usage in building and construction along with 3D printing. The rheological characteristic is an important factor in printability. This article begins with a review of the literature, followed by a quick overview of recent advancements in the topic. Following that, the approaches for improving the rheological property are described.

KEY WORDS: 3D printing, Cementitious Composites materials , rheology .concrete

1 INTRODUCTION

Concrete is among the most often utilised building materials on the planet. It has a lot of good qualities, such as ease of use, a large number of raw material suppliers, and so on. It has a high level of dependability, making it an important structural material in modern civil engineering . Despite all of the advantages listed above, typical concrete is a brittle material with limited tensile strength and crack resistance, which restricts its engineering applications [1]

Cementitious Composites with combination of short fibers are a type of cementitious composite It has a similar appearance. With the exception of tensile characteristics , mechanical strength is comparable to conventional concrete in all aspects.. Unlike regular concrete, which is fragile and susceptible to cracking, it is a particular type of concrete. Concrete with a high degree of tensile ductility and toughness. The ultimate tensile strain Under uniaxial tension tests, it varies between 3% and 5%. it can be used after initial matrix cracking. With strain-hardening behavior, you can maintain a higher level of loading. Cracks in such composites may be adequately controlled under 60 m and have a multi-cracking pattern it is a possible high-performance material for use in building and construction, along with 3D printing, due to its unique mechanical feature.[2,3]

3D printing is a layer-by-layer manufacturing technique that creates solid parts .Due to its advantages over traditional manufacturing techniques, such as decreased lead times, flexibility in generating complicated shapes, and so on, it has drawn interest in a variety of areas, including building and construction. Various 3Dprinting technologies, including such Contour Crafting D

form, and Concrete Printing, have been tried by researchers in the building and construction business [4]

2 RHEOLOGICAL PROPERTY

Rheological property control is crucial during the printing process to ensure smooth flow during pumping and speedy settling of the concrete following extrusion/printing. A single coefficient of viscosity at a certain temperature characterizes a classic Newtonian fluid, such as water. Though viscosity varies with temperature, it is unaffected by shear rate .Non-Newtonian fluids are a broad category of fluids in which the relationship between shear stress and shear rate is not linear.[5]
Many studies have attempted to influence the rheological properties of concrete by altering the mix design. Slag is a type of cement replacement material. Integrating slag with a 15 percent maximum content By reducing the cement dosage in concrete, the workability of the concrete can be improved. Concrete is a two-phase substance made up of coarse and fine aggregates.CA and mortar are two types of aggregate. Higher CA content and finer aggregates are usually associated with higher CA content. greater yield stress and viscosity, to name a few rheological parameters As a result, plastic viscosity and relative yield stress are reduced, PVA fiber dispersion, and such composite performance were all highly correlated By altering the mixing procedure, it is also feasible to adjust the rheological properties of concrete.[6]
The workability of admixtures (melamine formaldehyde sulfonate and naphthalene formaldehyde sulfonate) is improved by delaying their inclusion In addition, mixing at a high shear rate improves flow ability (lower viscosity) Vibration can also lower yield stress by roughly half compared to no vibration, although it has no effect on plastic viscosity Modification of the rheological characteristic can also be accomplished by adding admixtures. The use of a super plasticizer reduces yield stress, but the decreased water content increases plastic viscosity, resulting in sticky, difficult-to-handle mixtures The viscosity of cement paste and concrete is affected by mineral admixtures. Among six distinct mineral admixtures, ultrafine fly ash is considered the best mineral admixture for reducing yield stress and viscosity, comprising coarse fly ash, fly ash, fine fly ash, ultra-fine fly ash, metakaolin, and silica fume Due to the greater surface areas of silica fume particles, combining silica fume with concrete reduces workability as compared to no silica fume addition [7]

3. PRINTABILITY CHALLENGES

In a typical 3D concrete printing procedure, basic components are first combined in a mixer. which is being delivered to a container and then to a nozzle via a delivery system. The foundation is made of concrete are produced layer by layer when they reach the nozzle to form the solid portions previously stated, the Bingham Model can be used to characterize the rheological behavior of concrete. The applied shear stress (e.g., pressure from the air pump) should be greater than the yield. It is critical to maintain a seamless process so that the distribution and nozzle systems do not become clogged. To avoid excessive slumping, the viscosity should be high. Furthermore, open time is an important metric for the working environment. The material's window is also a

parameter influenced by the concrete's viscosity dynamics. The ability of freshly mixed concrete to be transferred from the container is referred to as pumpability.to the spray nozzle The concrete must be kept at a low viscosity during the whole flow phase.to go freely via the delivery system Furthermore, the concrete should not harden or crack. Obstructing the pipe As a result, the rheological quality of fresh concrete is a critical factor. This should be taken into account during the pumping procedure As a result, researchers should explore using the methods outlined in Section 2 to reduce the viscosity of concrete during this procedure. Build ability is another important feature of printed such fibre induced cementitius composites materials [8,9].

4. CONCLUSION

The literature on concrete printing is reviewed in this article. In the first section, fibre matrixed Cementitious Composites , 3D printing , and rheology are discussed briefly, followed by methods for controlling the rheological properties of concrete in Section 2. In the third section, various variables linked to rheological characteristic control in concrete printing are discussed. The rheological quality of concrete has a big impact on concrete printing. It is advised that future research try other strategies to manage the viscosity for printing, such as modifying the mixing method, adding different admixtures, and so on.

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