https://doi.org/10.36375/prepare_u.iei.a206

# Flexural study of Nano concrete for structural elements - A review

Dr Kaarthik M, Ms. Karthikadevi S, Uma Chandru, Jayandiran R

*Department of Civil Engineering*
*Coimbatore Institute of Technology, Avinashi Road, Civil Aerodrome Post, Coimbatore, Tamil Nadu – 641014, India.*

{Corresponding author's email: kaarthik@cit.edu.in}

**Abstract - Materials science is consistently one of the active research topics in present scenario with ultimate motive is to enhance the strength and durability of any materials. In civil engineering nano concrete becomes popular globally in present time which has potential to produce concrete with more strength and durable and it also considered as a concrete for future generations. This article presents brief information about performance of nano concrete under flexural strength. The article covers deep insight of previously published quality literature along with future scope and conclusion.**

**Keywords - Nano concrete, materials, flexural strength. Concrete technology, materials science.**

## INTRODUCTION

In civil engineering concrete is a most essential materials which helps structure to attain rigid state to resist from damage or hazard. Nano concrete is one among the advancement in concrete technology to develop the performance of concrete Pietro Di Maida et al. (2018) studied that the impact of a surface nano- silica remedy completed with the sol-gel process on the post breaching dealings of polypropylene macro synthetic fiber strengthen solid practically examined. The current works enlarge former exercises and systematically inquire on the compatible enhancement of a sole synthetic macro fiber execution's bonding competency employing a come-away trial. The comparative explication completes with 3-point bending trials on marked beam patterns is applied to estimate the nano-silica remedy impacts on the concrete post breaching dealings. The connection amidst the nano-silica coating and the solid hydration product enhances the resistive shear stress and thus the entire power soaking as notified by the rise of the remaining power during the post breaching stage [1].

Natarajan et al. (2021) discussed that the work's study estimates the improvement in applying exteriorly confined single- and double-layer Glass Fiber Reinforced Polymer (GFRP) rolled nano concrete columns. The column patterns were supplied with GFRP laminates with two various fattening. GFRP rolled have vouched to be a superior option for utilization infrastructure exercises. This work has been formed on traditional square columns and GFRP laminates nano concrete columns beneath axial weights. The practical rolled nano concrete columns when juxtaposed with recommending traditional concrete columns [2].

Anwar. M. Mohamed. (2014) studied that the work examined the impact of nanoparticles on the mechanical characteristics at various ages of solid. Various blending has been researched, adding nano-silica (NS), NC (nano clay), or NC and NC team-wise with several percentages. The percentage of 3% nanoparticles comprising 25% NS and 75% NC gave the maximum mechanical characteristics describing each flexural and compressive powers, among other percentages. Outcomes of this work exhibit that nanoparticles can be very impactive in enhancing mechanical competency of concrete, nano-silica is more impactful than NC in mechanical competency, and humid blend gives superior proficiency to arid blend [3].

Pavan Kumar Diddi et al. (2021) suggested that the work scrutinizes nanomaterials' effect on micro-mechanical characteristics of solid. The impact of nanomaterials on blooming, reinforcement characteristics of fast-track remake concrete. Nanomaterial impression on setting time, functionality, vulnerability, and mechanical. The impression of several nanomaterials on the microstructure of solid is analyzed. Fiber strengthens several nanoparticles' impact in the cementitious process of traditional, binary mixing, and ternary mixed blocks of cement are not as

much of perambulation. Impression of accelerators on nanomaterial consolidated cementitious methods can be well-read for evolving fast track restoration pieces of equipment [4].

*A. Application of Nano concrete in structural elements*

Structural applications of nano concrete produce satisfactory outcomes compared to other types of concrete. Jemimah Carmichael et al. (2021) expressed the formed effort to examine the impact of substitution of cement with nanomaterials in solid on the adequate power of concrete. The suppleness index was set up to rise to 40% substitute and on the other side where the suppleness index was set up to reduce. The rise in suppleness index was settled in the range 1.2-2.42. Nanomaterials in solid enhance the mechanical characteristics of solid, and the dealings beneath the influence are studied as per the drop load effect process. The outcomes signal that the solid with nanomaterials show better execution against loading when juxtaposed with Normal Cement Concrete (NCC) [5].

*1) Flexural behavior*: Abiraami et al. (2021) reported that the practical study goes through with it by preparing five solid blendings varying 10% m-Sand limit 60-100% by a load of fine clean, 15% by a load of cement, and 1% by volume of steel staple. Metakaolin proposed to grow the straining and the mixing nature of solid. It was powerful inspissate without any opening in concrete samples, as Metakaolin includes the blend that is more purified than cement particles. Several proportions of M30 grade solid were scrutinized by convection flexural and mechanical dealings trials. The outcomes acquired are fair for 80% of the M sand substitute. Extra M Sand substitute is inclined to decrease concrete power [6].

Estefania Cuenca et al. (2021) discussed that the mechanical execution and the autogenous self-curing ability of an ultra-high execution fiber strengthened cementitious coalescent, storing alumina nanofibers and translucent admixture as a self-curing stimulant have been examined in the work. The deputed multi-trial practical depiction procedure yields relevant outcomes as exhibited by the correlation amidst the realization of both removability and mechanical characteristics with the completion of the loopholes. The micro-structural inquiry has integrated the aforementioned practical program to reaffirm alumina nanofibers' precision in improving the irrevocability execution of the examined coalescent. The inclusion of alumina nanofibers in the blend made eventual by inflexible disposition method to obtain the convenient, close attention in the adjournment is likely to yield to a perfect stress re-dispensation ability in the breached state, as corroborator by the maximum number and dilute breadth of the blowout that form during pre-top static spreading state [7].

Ethar Thanon Dawood et al. (2021) presented that the study targets to manufacture sustainable and economic briquettes applying glass dust and steel slag dust as substitutes of cement and well-read the impact of the include nano-silica to solid brick blends to enhance the characteristics of bricks. There are two curing processes added to examine the remedy regime's impact on some essential physical and mechanical characteristics of solid bricks. From the trial outcomes, it has been found that the exploitation of 2.5% or 3.5% of nano-silica in solid brick mixes can remarkably raise the suppressible and flexural powers at early and late ages. The consequences of arid shrinkage with ebullition remedy samples at all ages exhibit that arid shrinkage's importance was flabbily superior to those of sample compression at normal remedy process [8].

Abeer M.Erfan et al. (2020) presented that the work examined the flexural dealings of concrete beams strengthened with glass fiber strengthened polymer GFRP bars. This inquiry exhibits GFRP bars' benefits in hardening concerning steel impaction in either Nano-Solid or HSC ( high strength concrete ) blending. The foil weights of strengthening beams with GFRP bars raised concerning beams hardening applying steel bars. A non-linear limited element program compatible with the practical one was directed, applying ANSYS 14.5 TO calibrate all practical beam outcomes. The consequence signals better annexure amidst experimental and systematical outcomes [9]. Figure 1 depicts laboratory set up for flexural study.

https://doi.org/10.36375/prepare_u.iei.a206

Fig. 1 laboratory set up for flexural study [10]

Soonho Kim et al. (2018) expressed that the work examines the flexural and breaching dealings of UHPFRC (Ultra high-performance fiber reinforced concrete) previous and through divestiture to cryogenic temperatures for LNG (Liquefied natural gas) stockpile tank exercises. NC (regular concrete), which has been applied to make LNG stockpile tanks in Korea, was also contemplating juxtaposing. Trial outcomes hint that UHPFRC shows superior hindrance to microcrack creation beneath these situations. UHPFRC also exhibits virtually perfect flexural execution early and after divestiture to cryogenic cooling juxtaposed to standard concrete. CaCo3 creation consequence in improved flexural execution, adding supreme power, drift ability, and power soaking ability as juxtaposed to the unbroken UHPFRC samples without any blowout [11]

Yunxing Du et al. (2021) studied that the current work examined the flexural behavior of execution-founded alkali-actuate slag-fly ash solid beams. There are four static cant trials executed on 12 AAC ( Alkali activated concrete ) beams, and three common PCC ( Portland cement concrete ) beams to inquire the impacts of solid power, rebar ratio, and beam profundity on the flexural execution. The trial outcomes exhibited that the flexural dealings of ACC beams resembled that of PCC beams. The rise of the beam profundity remarkably enhanced the flexural rigidity and weight carrying ability of ACC beams. The present formation code nicely vaccinated the emphatic flexural rigidity at service situation and the weight carrying ability. Therefore the present formation code is appropriate to the design of AAC beams exhibition flexural behavior [12] [13]

SU-Jin Lee et al. (2014) reported that the anatomical nano artificial and steel fibers were applied to decrease the quantity of steel rebar dispensation in precast strengthened solid coalescent members. The flexural powers were acquired for every blending perfunctory of the fiber volume numerator. The flexural ferocity enhanced with the fiber volume fraction and superior flexural ferocity importance were acquired for blending with 20kg/m3 of steel fiber. The trial outcomes proved that the hybrid fiber strengthened cement coalescent contented the required situations to supersede the general hardening bars in pursuance of the RTLEM standard when the blend included 0.4% of nano artificial 20kg/m3 of steel fiber. The utmost weight of the precast HFRC member was 30.1% oversize than its designed ideal weight, and its execution was continual to the precast SFRC member [14] [15]. Somasri et al. (2021) presented that the study examines the rheological and mechanical characteristics of GO (Graphene Oxide) consolidated HSSCC (high strength self-compacting concrete ). By converting cement at the nanoscale, they can enhance the micro framework of cement. That such nanoparticle is Graphene Oxide. GO is consolidated in HSSCC to enhance the execution competency. There are several processes to create HSSCC, the best between them is by enhancing the microstructure of cement applying GO. It is the developed nano substance that obtained valuable levels in different fields [10] [16].

*2 Conclusion*:

In this proposed review article demonstrated a behavior of nano concrete under flexure which performs satisfactory outcomes. Self-compacting concrete will be most welcomed invention among in nano concrete also provided solid results when it is subjected to flexure. However, improvement is mandatory in durability aspects which slightly decreases compared with conventional concrete. Additionally, it provides great resistance to flexural strength which makes nano concrete as successful.

REFERENCES

[1] P. Di Maida, C. Sciancalepore, E. Radi, and F. Bondioli, “Effects of nano-silica treatment on the flexural post cracking behaviour of polypropylene macro-synthetic fibre reinforced concrete,” Mech. Res. Commun., vol. 88, pp. 12–18, 2018, doi: 10.1016/j.mechrescom.2018.01.004.

[2] S. Natarajan and S. Senthil Selvan, “Experimental study on axial compression behaviour of glass fibre reinforced polymer (GFRP) wrapped nano material concrete columns,” Mater. Today Proc., vol. 39, pp. 748–757, 2020, doi: 10.1016/j.matpr.2020.09.444.
[3] A. M. Mohamed, “Influence of nano materials on flexural behavior and compressive strength of concrete,” HBRC J., vol. 12, no. 2, pp. 212–225, 2016, doi: 10.1016/j.hbrcj.2014.11.006.
[4] D. Pavan Kumar, S. Amit, and M. Sri Rama Chand, “Influence of various nano-size materials on fresh and hardened state of fast setting high early strength concrete [FSHESC]: A state-of-the-art review,” Constr. Build. Mater., vol. 277, p. 122299, 2021, doi: 10.1016/j.conbuildmat.2021.122299.
[5] M. Jemimah Carmichael and G. Prince Arulraj, “Impact resistance of concrete with nano materials,” Mater. Today Proc., vol. 37, pp. 677–684, 2020, doi: 10.1016/j.matpr.2020.05.635.
[6] R. Abiraami et al., “Mechanical and flexural behaviour study on fibrillated concrete as partial replacement of M-Sand and metakaolin,” Mater. Today Proc., vol. 39, pp. 776–780, 2020, doi: 10.1016/j.matpr.2020.09.507.
[7] E. Cuenca, L. D’Ambrosio, D. Lizunov, A. Tretjakov, O. Volobujeva, and L. Ferrara, “Mechanical properties and self-healing capacity of Ultra High Performance Fibre Reinforced Concrete with alumina nano-fibres: Tailoring Ultra High Durability Concrete for aggressive exposure scenarios,” Cem. Concr. Compos., vol. 118, p. 103956, 2021, doi: 10.1016/j.cemconcomp.2021.103956.
[8] E. T. Dawood and M. S. Mahmood, “Production of Sustainable concrete brick units using Nano-silica,” Case Stud. Constr. Mater., vol. 14, p. e00498, 2021, doi: 10.1016/j.cscm.2021.e00498.
[9] A. M. Erfan, H. E. Hassan, K. M. Hatab, and T. A. El-Sayed, “The flexural behavior of nano concrete and high strength concrete using GFRP,” Constr. Build. Mater., vol. 247, p. 118664, 2020, doi: 10.1016/j.conbuildmat.2020.118664.
[10] M. Somasri and B. N. Kumar, “Materials Today : Proceedings Graphene oxide as Nano material in high strength self-compacting concrete,” Mater. Today Proc., no. xxxx, 2021, doi: 10.1016/j.matpr.2020.12.1085.
[11] S. Kim, M. J. Kim, H. Yoon, and D. Y. Yoo, “Effect of cryogenic temperature on the flexural and cracking behaviors of ultra-high-performance fiber-reinforced concrete,” Cryogenics (Guildf)., vol. 93, no. June, pp. 75–85, 2018, doi: 10.1016/j.cryogenics.2018.06.002.
[12] Y. Du, J. Wang, C. Shi, H. J. Hwang, and N. Li, “Flexural behavior of alkali-activated slag-based concrete beams,” Eng. Struct., vol. 229, no. August 2020, p. 111644, 2021, doi: 10.1016/j.engstruct.2020.111644.
[13] D. S. Vijayan, J. Revathy, and R. Scholar, “Study on Retrofitted RCC Beams,” Int. J. Eng. Sci. Comput., vol. 6, no. 5, p. 5664, 2016, doi: 10.4010/2016.1381.
[14] S. J. Lee and J. P. Won, “Flexural behavior of precast reinforced concrete composite members reinforced with structural nano-synthetic and steel fibers,” Compos. Struct., vol. 118, no. 1, pp. 571–579, 2014, doi: 10.1016/j.compstruct.2014.07.042.
[15] D. S. Vijayan and J. Revathy, “‘Flexural behavior of reinforced and pre-stressed concrete beam using finite element method,’” Int. J. Appl. Eng. Res., vol. 10, no. 1, pp. 717–736, 2015.
[16] E. Koda, A. Szymanski, and W. Wolski, “Field and laboratory experience with the use of strip drains in organic soils,” Can. Geotech. J., vol. 30, no. 2, pp. 308–318, 1993, doi: 10.1139/t93-026.