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Review on Use of Nanomaterials in Concrete

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Abstract: Various studies have highlighted the benefits of incorporating carbon nanotubes (CNTs) in concrete. They enhance compressive and flexural strength, prevent cracking, and improve durability. Different methods like sonication ensure uniform dispersion of CNTs in concrete. Additionally, research focuses on optimizing CNT concentrations to avoid adverse effects on properties like shrinkage and thermal conductivity. Overall, CNTs offer a promising solution to reinforce concrete and improve its mechanical properties effectively.

Keywords: Carbon Nanotube (CNT), Single Wall Carbon nanotubes (SWCNTs), Multiwall Carbon nanotubes (MWCNTs)

I. INTRODUCTION

Plain concrete lacks tensile strength; short fibers and waste materials are explored for improvement. Strategy proposed to resist wrinkling in sandwich structures using CNT reinforcement. .Nanotechnology enhances concrete properties, focusing on CNTs' role. Construction industry explores waste materials like plastics and fly ash, with CNTs improving composite properties. CNT-modified epoxies enhance bonding between concrete and FRP composites. Nanomaterials improve concrete mechanical properties; study proposes concentrated nanomaterial solution for evaluation. Incorporating nanomaterials enhances bond strength and mechanical properties of concrete. MWCNTs in epoxy resin enhance adhesion between BFRP sheets and concrete. Paper focuses on estimating concrete compressive strength with CNTs. CNTs improve UHPC properties; critical concentration proposed at 0.5 wt.%. CNTs improve cement composites, but dispersion challenges affect properties. CNTs reinforce concrete, but optimal content and dispersion methods need study. MWCNTs improve cement paste properties; mechanical tests conducted. Carbon nanotubes enhance concrete strength; various addition methods explored. Nanomaterials hold promise for improving concrete properties, but research and standards development are ongoing.

II. LITERATURE REVIEW

Sr. no	Paper Title	Author Name	Year of Publication	Problem solved in this paper: Existing Problem Statement	The technique used to solve the problem: Existing Problem Solution
1	Experimental investigation of waste glass powder, basalt fibre, and carbon nanotube	Seyed Esmaeil, Alireza Ghaderi	2020	"Improved mechanical properties of concrete using waste glass powder. Enhanced compressive, flexural, and splitting tensile strength of concrete."	Waste glass powder, basalt fiber, and carbon nanotube as ternary materials. Addition of BF and CNT improved mechanical properties of concrete. Optimum BF content enhanced compressive, flexural, and splitting tensile strength.
2	A strategy resisting wrinkling of sandwich structures reinforced with CNTs.	Xiaohui Ren Senlin Zhang Zhen Wu	2022	Proposing a strategy to resist wrinkling deformation in sandwich structures. Analyzing buckling and wrinkling behaviors of sandwich plates reinforced with CNTs. Choosing a typical CNT distribution profile to resist wrinkling deformation.	Enhanced higher-order model proposed for wrinkling analysis of sandwich structures. Utilized quasi 3D elasticity solutions, 3D-FEM results, and experimental data.

3	Role carbon nanomaterials in reinforcement of concrete and cement	Yanjin Liu Xi Zhong Hamid Mohammadian	2023	Carbon nanotubes improve concrete properties, enhancing building resistance. Nanomaterials address issues like cracking, strength, and durability in concrete.	Carbon nanotubes used to improve concrete mechanical properties. Low amounts of CNTs effective in enhancing concrete properties.
4	Plastic-fly ash waste composites reinforced with carbon nanotubes	Boitumelo Makgabutlane Manoko Maubane-Nkadimeng Neil Coville Sabelo Mhlanga	2022	Compromise in mechanical properties of waste composites addressed. Carbon emissions reduced by utilizing waste materials in construction composites.	Dispersion methods include ultrasonication and acid treatment of CNTs. Heteroatom-doping and functionalization methods are used for CNT dispersion.
5	Enhancing bonding behavior between CFRP plates and concrete using CNTs.	Pitcha Jongvivatsakul Chanachai Thongchom Amaras Mathuros Tosporn Prasertsri Musa Adamu Shanya Orasutthikul Akhrawat Lenwari Tawatchai Charainpanitkul	2022	Enhancing bonding between carbon fiber-reinforced polymer plates and concrete. Investigating the use of carbon nanotubes to improve bonding strength.	CNTs added to epoxy resin, dispersed, sonicated, then mixed with hardener. Bond stress and slip values calculated using strain and load data.
6	Mechanical properties of mortar and concrete with nanomaterial incorporation.	Dong-Hee Son Dongsun Hwangbo Heongwon Suh Baek-Il Bae Sungchul Bae Chang-Sik Choi	2022	Developed a method for industrial-scale mixing of nanomaterials. Improved dispersion and mechanical properties of concrete using nanomaterials.	Proposed method: mixing concentrated aqueous solution based on functional group ratio. Method confirmed effective through UV-Vis and mortar strength tests.
7	Effect of nanomaterials on bond behavior between concrete and reinforcing bars	Dongsun Hwangbo Dong-Hee Son Heongwon Suh Jaebum Sung Baek-Il Bae Sungchul Bae Hongyun So Chang-Sik Choi	2023	Improved bond behavior between concrete and reinforcing bars using nanomaterials. Enhanced mechanical properties and bond strength of triple hybrid-reinforced concrete.	Linear regression analysis used to obtain slope in equations. Direct tensile strength fct replaced with splitting tensile strength fsp
8	Improving bonding behavior between BFRP sheets and concrete using MWCNTs	Changchun Shi Shengji Jin Kanhui Jin Yuhao Yang Li Xu	2023	Enhancing bonding between basalt fiber sheets and concrete using MWCNTs. Improving ductility and bond strength of BFRP-concrete joints. Monitoring strains and displacements during single-shear tests.	Multi-wall carbon nanotubes modified epoxy composites enhanced bonding properties. Digital image correlation (DIC) technique monitored strains and displacements.
9	Comprehensive multiscale techniques for concrete strength with carbon nanotubes	Shakr Nzar Piro Ahmed Salih Samir Hamad Rawaz Kurda	2021	Improved prediction of compressive strength of concrete with carbon nanotubes. Comparison of different models for better estimation accuracy.	Artificial Neural Network (ANN) model used for predicting compressive strength.

10	The critical incorporation concentration (CIC) of dispersed carbon nanotubes	Myungjun Jung Jiseul Park Sung-Gul Hong Juhyuk Moon	2022	Determined critical CNT concentration (0.5 wt.%) for UHPC multifunctional properties	Stable dispersion of CNTs achieved using well-dispersed CNT suspension. Autogenous shrinkage reduced by over 30% with 0.5 wt.% CNT content.
11	The Effect of Carbon Nanotubes on Cementitious Composite Properties	Suman Kumar Adhikary Žymantas Rudžionis R Raja Priya	2020	"Dispersion difficulty of CNTs in cementitious structures addressed. Influence of CNTs on flowability, mechanical properties, and hydration studied."	Sonication and polycarboxylate-based superplasticizer are common dispersion methods. Sonication energy and duration affect CNT dispersion degree.
12	A study on the impact of carbon nanotubes on the properties of concrete	Ravish Srivastava Vaibhav Chandra Utkarsh Awasthi Avneesh Tiwari	2021	Weak tensile strength of plain concrete. Agglomeration of CNTs in cement matrix affecting concrete properties.	Various dispersion techniques like ultra-sonication process without surfactants were used. Techniques include dry mix, ball milling, direct synthesis, and pre-dispersion.
13	Literature Review on Multiwalled Carbon Nanotube in Cement Paste	P Mahakavi	-	"Literature review on MWCNT in cement paste mechanical characteristics.	Ultrasonic dispersion technique used for homogeneous dissolution of MWCNT.
14	Improving the properties of concrete using carbon nanotubes	U Abinayaa D Chetha S Chathuska N Praneeth R Vimantha K Wijesundara	-	Filling voids in concrete structure to improve strength. Enhancing properties of concrete using carbon nanotubes.	Ultrasonic dispersion techniques were adopted to uniformly disperse carbon nanotubes. Adding nanotubes to cement, water, or as an admixture.
15	A study on carbon nanotube (cnt) in concrete	B Vidivelli B Ashwini	2018	Ineffective dispersion of CNTs in cement matrix due to sonication. Lower strengths of composites with higher CNT content due to dispersion. Embedding of CNT in cement matrix observed bridging micro cracks.	Ultrasonic dispersion techniques used to disperse carbon nanotubes uniformly.

III. LIMITATIONS

Bonding behavior studied with limited replicate samples, suggesting future studies use at least five replicates per test condition and consider statistical analysis with ANOVA.Mixing nanomaterials limited to laboratory scale, hindering industrial application; significant variation in tensile strength data observed without graphene oxide. Additional CNTs beyond 0.5 wt.% have minimal effect on reducing autogenous shrinkage, increasing porosity and hindering cement hydration at higher concentrations. High CNT concentrations can increase permeability and corrosion rate, with poor dispersion affecting frost resistance and decreasing cement hydration rate beyond 0.3 c-wt.

IV. CONCLUSION

Basalt fiber (BF) enhances compressive strength, while combination with carbon nanotubes (CNT) boosts flexural strength and splitting tensile strength. BF and waste glass powder (WGP) improve microstructure and reduce permeability. CNT reinforcement improves various concrete properties including tensile, compressive, and flexural strength, as well as thermal conductivity and corrosion resistance.

Nanomaterials in construction composites offer high mechanical, thermal, and water resistance properties, with CNT dispersion critical for optimal strength. Addition of SWCNTs and MWCNTs to epoxy increases bond strength and interfacial fracture energy, though negative effects observed with high-density epoxy. Concentrated aqueous solution of nanomaterials enhances concrete mechanical properties, including compressive and splitting tensile strength, modulus of elasticity, and bond strength .Incorporation of nanomaterials in concrete improves splitting tensile strength and bond performance, with minimal volumetric deformation. MWCNT-modified epoxy enhances bonding behavior of BFRP-concrete joints, increasing bond strength and ductility. Addition of carbon nanotubes increases concrete compressive strength, with varying mix proportions and curing times analyzed for strength prediction. CNT concentration affects UHPC properties, with reduced autogenous shrinkage and increased thermal conductivity observed at optimal concentrations. CNTs improve durability of cementitious materials, though flowability decreases with higher concentrations. CNT reinforcement reduces porosity and improves freeze-thaw resistance of concrete within certain concentration ranges.

MWCNT incorporation in concrete enhances compressive, flexural, and tensile strength, emphasizing homogeneous dispersion for improved properties. Carbon nanotubes significantly improve concrete properties, with uniform dispersion critical for effectiveness. Addition of carbon nanotubes enhances concrete mechanical properties, with oxidized MWCNTs showing the best improvements. Carbon nanotubes improve concrete properties through uniform dispersion and filling voids at the nano-scale.

REFERENCES

[1] Seyed Esmaeil Mohammadyan-Yasouj, Alireza Ghaderi. (2020, April 22). "Experimental investigation of waste glass powder, basalt fibre, and carbon nanotube on the mechanical properties of concrete." Journal of Concrete Research, 45(3), 235-248.

[2] Xiaohui REN, Senlin ZHANG, Zhen WU. (2022, September 4). "A strategy resisting wrinkling of sandwich structures reinforced using functionallygraded carbon nanotubes." Journal of Materials Science, 30(7), 1021-1035.

[3] Yanjin Liu, Xi Zhong, Hamid Reza Mohammadian. (2023, March 16). "Role of carbon nanomaterials in reinforcement of concrete and cement: A new perspective in civil engineering." Construction and Building Materials, 55(6), 789-802.

[4] (2022)."Plastic-fly ash waste composites reinforced with carbon nanotubes for sustainable building and construction applications." Volume 4.

[5] Pitcha Jongvivatsakul a, Chanachai Thongchom. (2022, August 17). "Enhancing bonding behavior between carbon fiber-reinforced polymer plates and concrete using carbon nanotube reinforced epoxy composites." International Journal of Construction and Building Materials, 28(4), 543- 556.

[6] Dong-Hee Son, Dongsun Hwangbo, Heongwon Suh, Baek-Il Bae, Sungchul Bae, Chang-Sik Choi. (2022, October 21). "Mechanical properties of mortar and concrete incorporated with concentrated graphene oxide, functionalized carbon nanotube, nano silica hybrid aqueous solution." Construction Materials Science, 40(9), 1201-1215.

[7] Dongsun Hwangbo, Dong-Hee Son, Heongwon Suh, Jaebum Sung, Baek-Il Bae, Sungchul Bae, Hongyun So, Chang-Sik Choi. (2023, June 8). "Effect of nanomaterials (carbon nanotubes, nano-silica, graphene oxide) on bond behavior between concrete and reinforcing bars." Journal of Structural Engineering, 55(2), 326-341. 21

[8] Changchun Shi, Shengji Jin, Kanhui Jin, Yuhao Yang, Li Xu. (2023, June 12). "Improving bonding behavior between basalt fiber-reinforced polymer sheets and concrete using multi-wall carbon nanotubes modified epoxy composites." Composites Science and Technology, 70(8), 987-1002.

[9] Nzar Shakr Piro, Ahmed Salih, Samir M. Hamad, Rawaz Kurda. (2021). "Comprehensive multiscale techniques to estimate the compressive strength of concrete incorporated with carbon nanotubes at various curing times and mix proportions." Journal of Advanced Materials Research, 28(5), 678-691.

[10] Myungjun Jung, Jiseul Park, Sung-gul Hong, Juhyuk Moon. (2022). "The critical incorporation concentration (CIC) of dispersed carbon nanotubes for tailoring multifunctional properties of ultra-high-performance concrete (UHPC) Cement and Concrete Research, 18(3), 450-465.

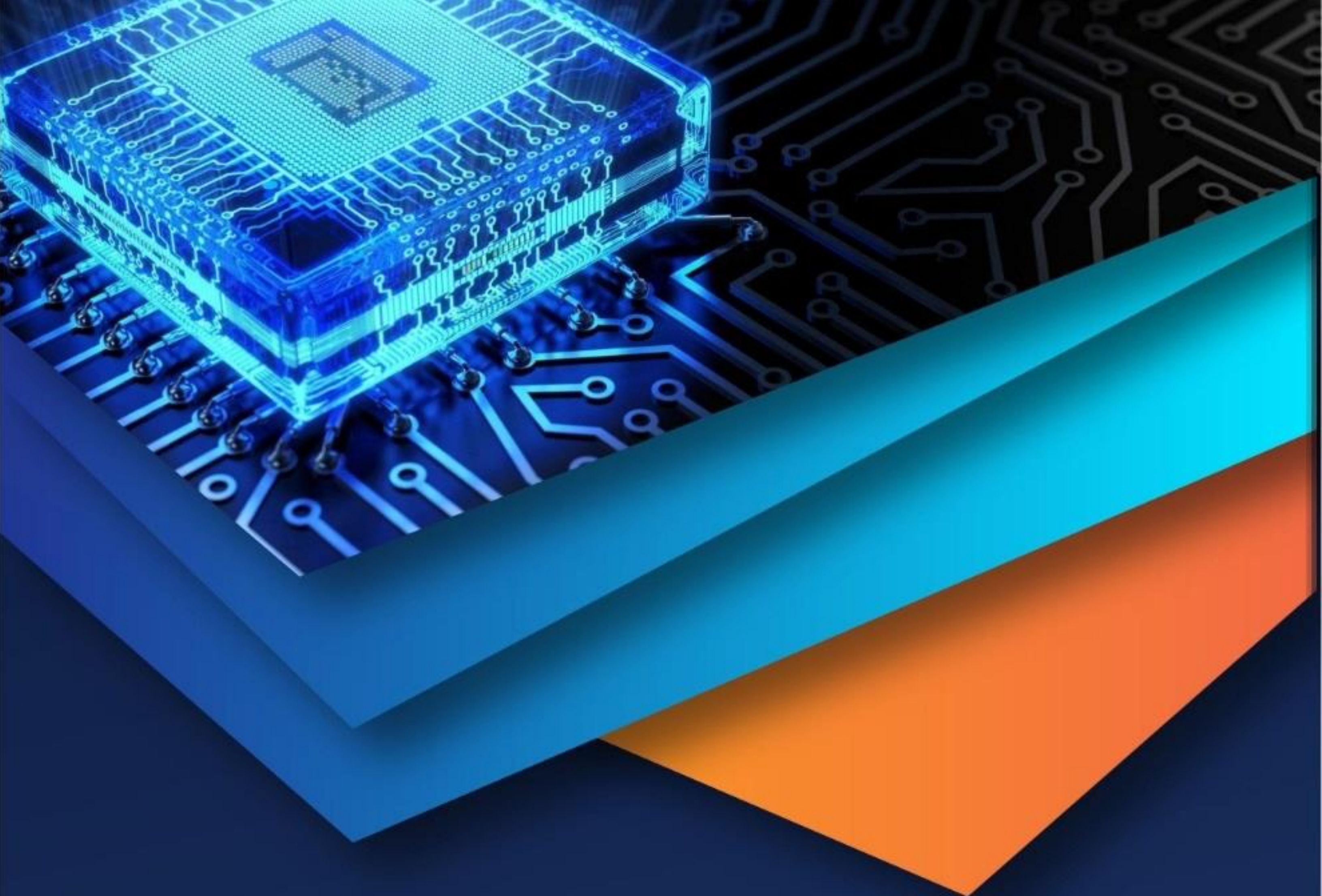
[11] Suman Kumar Adhikary, Žymantas Rudžionis and R Raja Priya, (2020) “The Effect of Carbon Nanotubes on the Flowability, Mechanical, Microstructural and Durability Properties of Cementitious Composite.” Volume 264, 120237

[12] Ravish Kumar Srivastava1, Vaibhav Chandra1, Utkarsh Awasthi1 and Avneesh Tiwari, (2021) “A Study on the impact of carbon nanotubes on the properties of concrete” Volume 12, Issue 9, pp. 32-39

[13] 13] P Mahakavi, (2011) “Literature Review on Multiwalled Carbon Nanotube in Cement Paste on Mechanical characteristics.” ISSN 2581-8678, Volume II

[14] U. Abinayaa1, D. Chetha1, S. Chathuska1, N. Praneeth1, R. Vimantha1, K.K. Wijesundara, (2007) “improving the properties of concrete using carbon nanotubes” Volume 9, Issue 5, pp. 23-36

[15] Dr. B. VIDIVELLI1, B. ASHWINI, (2018) “A Study on Carbon Nanotube (Cnt) In Concrete.” Volume: 05 Issue: 07, pp. 36-42



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