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# To Study Behavior of Concrete Filled PVC Tubes by using ANSYS – A Review

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## Abstract

Concrete Filled PVC Tubes (CFPT) have emerged as an innovative composite structural system combining the strength of concrete with the lightweight, durable, and corrosion-resistant properties of Polyvinyl Chloride (PVC). A literature highlights CFPT as a sustainable alternative to conventional concrete-filled steel tubes (CFST), particularly in low-cost and temporary structures. Research findings indicate that PVC confinement improves the ductility, energy absorption, and crack resistance of concrete while reducing weight and maintenance requirements. Studies further explore the influence of parameters such as tube thickness, concrete grade, slenderness ratio, and loading conditions on axial and flexural performance. Compared to traditional steel confinement, PVC provides weaker confinement but offers advantages in economy, durability in aggressive environments, and ease of handling. Recent investigations also focus on hollow and fiber-reinforced CFPT systems, enhancing their weight-to-strength ratio and structural efficiency. Overall, the literature suggests CFPT as a promising solution for lightweight, economical, and corrosion-resistant structural applications, though long-term performance, large-scale implementation, and standardized design guidelines remain areas requiring further research.

**Keywords:** CFPT, CFDPT, Ansys, CFPT Columns, PVC Tube.

## 1. Introduction

The continuous advancement in structural engineering has led to the exploration of innovative construction materials and composite systems that combine strength, economy, and durability. Among such developments, concrete-filled tubes have gained significant attention due to their ability to enhance the performance of structural members by utilizing the composite action between the infilled concrete and the surrounding tube. While steel tubes have been widely studied and implemented, the use of Polyvinyl Chloride (PVC) tubes as a permanent formwork and confining material offers an economical and lightweight alternative with advantages such as corrosion resistance, ease of handling, and reduced construction time.

Concrete-filled PVC tubes (CFPT) combine the compressive strength of concrete with the confinement and durability of PVC, resulting in improved load-carrying capacity, crack resistance, and reduced maintenance needs. Despite these advantages, the structural behavior of CFPT under various loading conditions is not yet fully understood, as research in this area remains relatively limited compared to steel tube counterparts. Understanding this behavior is crucial for assessing their feasibility in structural applications

This review paper aims to consolidate existing research on the behavior of concrete-filled PVC tubes analyzed using ANSYS. By critically examining previous studies, the paper seeks to highlight the structural performance, modeling approaches, key findings, and research gaps in the field. The outcomes of this review will provide a foundation for future investigations and contribute to the potential adoption of CFPT as an innovative, sustainable, and cost-effective solution in structural engineering.

## 2. Literature Review

**[1] Kukkala Mounika, Dr. Rex, Mr. Shivaramprasad** investigates in their research **"Experimental Investigation on Concrete Filled Unplasticized Poly Vinyl Chloride (UPVC) TUBES (2025)"** Axial loading on chemically and UV-resistant Unplasticized Polyvinyl Chloride (UPVC) tubes filled with concrete. In this study by using experimental method and analytical method findings are Unplasticized Polyvinyl Chloride (UPVC) tubes are a good building alternative for durability and cost effectiveness. That UPVC filled concrete tubes can carry axial stresses and resist deformation. These characteristics indicate that UPVC could substitute for sand and cement in areas with limited resources.

**[2] Kasun Wijesooriya, Damith Mohotti, Dakshitha Weerasinghe, Chi King Lee** studied on **"Behaviour of polymer-filled–concrete–steel double-skin tubular columns under combined lateral impact and axial compression loading (2023)."** The paper presents the behaviour of using a polymer layer to protective important structural parts like column from damage from impact. The idea of a Polyurethane Polymer Filled Concrete Steel Double Skinned Tubular Column is employed to reduce the damage to the important structural component. Two types of double skin column specimens packed with polymers were analyzed under low velocity impact. The compression strength of columns before and after damage was assessed. Polymer filled columns specimens compared with other specimens without the Polyurethane fill. Founds that the addition of Polyurethane has a beneficial and assists to maintaining the CFDSC structure strong. Polyurethane elastomer external layer for structural member works as a protective layer which exposed to impact damage.

**[3] Qiuying Chang, Chuanhai Zhao, Lei Xing, Waqas Ahmad, Nikolai Ivanovich Vatin, Fahid Aslam, Muhammad Ali Musarat, Muhammad Faisal Javed** conducted research on **"Concrete filled double steel tube columns incorporating UPVC pipes under uniaxial compressive load at ambient and elevated temperature (2022)."** The expected advantages of double skin tubular columns filled with concrete are demonstrated by this experimental investigation. These columns with steel tube outside, an interior UPVC pipe, concrete filled between these tubes. According to the examination of the experimental results, GB50936 (2014) yields the best results, followed by EC4 (2004) and AISC (2010). The specimen's performance at high temperatures is not greatly impacted by that type of infilled concrete and inner tube.

**[4] Aref A. Abadel, M. Iqbal Khan, Radhouane Masmoudi** studied on **"Experimental and numerical study of compressive behavior of axially loaded circular ultra-high-performance concrete-filled tube columns (2022)"** A total of seven columns were examined in the current experimental work. This research utilized various materials, including an external steel tube, an internal steel tube, an outer polyvinyl chloride (PVC) tube, and an external CFRP wrap, which is a polymer wrap strengthened with carbon fiber. A finite element (FE) model has been developed for tube columns filled with UHPFRC-filled tube columns. The findings are the outer steel tube had a better confinement impact on the core concrete as compared with the PVC tube and the CFRP sheet. In comparison to control specimens, the axial capacities of CFRP, PVC, and steel tube specimens increased by approximately 53%, 13%, and 27%, respectively.

**[5] Rosette Niyirora, Ferdinand Niyonyungu, Theogene Hakuzweyezu, Elyse Masengesho,** Ritha **Nyirandayisabye and Jean Munyaneza**. Researched on **"Behavior of concrete-encased concrete-filled steel tube columns under diverse loading conditions." (2022).** Increasing the safety of structures in seismically active areas was the aim of this concrete encased concrete filled steel tube (CE-CFST) column experiment. This report summarizes all of the findings that have been breakthroughs in the past ten years and offers a thorough review of the numerous theories that have been suggested by researchers in various regions. This kind of structure only utilizes less than 85% of its flexural capacity, according to research findings. Analytical, computational, and experimental study on these structures' behavior under various loading scenarios is still lacking. Along with delivering a comprehensive evaluation of the associated reinforced concrete (RC) and concrete-filled steel tube (CFST) columns, the authors emphasize the effectiveness of CE-CFST columns.

**[6] K. B. Manikandan and C. Umarani** conducted research on **"Understandings on the Performance of Concrete-Filled Steel Tube with Different Kinds of Concrete Infill." (2021).** The CFST specimens containing different types of concrete of the identical grade were the focus of both experimental and numerical studies. Regular concrete, expansive concrete, steel fiber reinforced concrete, and geopolymer concrete were among the varieties of concrete used in this experiment. The specimens underwent self-curing and underwater curing after being cast in the shape of cubes. It was found that self-curing, a possible technique for curing infilled concrete in CFST columns, did not influence the strength of the concrete. The same curing technique was applied to the CFST columns. Experimental and analytical approaches were found to differ by 41.33% in the CFST condition where expansive concrete was utilized. This study evaluated the characteristic strengths measured for the CFST columns with various types of concrete infill. Eurocode 4 was used to forecast the load bearing capacity of CFST columns during compression in order to perform the analytical results.

**[7] Yong Chang Guo, Shu Hua Xiao, Shu Wei Shi, Jun Jie Zeng, Wei Qiang Wang, Hong Chao Zhao** conducted experiment on **"Axial compressive behavior of concrete-filled FRP-steel** wire **reinforced thermoplastics pipe hybrid columns (2020)"** and in this investigate the axial compressive behavior of CFFSCs. The test results presents the stress strain curves, the dilation behavior and the effects of parameters (FRP ring clearing spacing, FRP thickness and fiber type) on the axial compressive behavior of CFFSCs have been presented. As well as predictions based on four existing design-oriented confinement models have been compared with the experimental results.

**[8] Shahram Mohammad Askari, Alireza Khaloo, Mohammad Hadi Borhani, Mohammad Sadegh Tale Masoule,** conducted researched on **"Performance of polypropylene Fiber reinforced concrete filled UPVC tube columns under axial compression (2020)"** This study investigates the performance of fiber reinforced concrete filled UPVC tube columns. Multiple concrete columns including eighteen unconfined and twenty four UPVC confined were tested under compression. Tests were conducted using UPVC constrained columns reinforced with polypropylene fiber. Examining how UPVC affected confined concrete columns and their ensuing load-bearing and ductility behavior in comparison to standard PVC and steel was crucial.

**[9] Rajendra Khapre, Kamesh Gonnade** conducted research on **"Experimental and Computational Study on Concrete Filled PVC Plastic Tubes Placed in Columns (2020)"** The experimental and analytical examination of CFPT is presented in this study. Since plastics and concrete don't mix well, plastic tubes were scratched to improve the bond. M20 grade concrete was used for cube sample and PVC tube filling. The variety of models was made possible by comparing experimental and computational data. The FE model was created to examine how CFPT behaved when it was positioned in columns with varying PVC tube diameters, thicknesses, tube counts, and CFPT column L/D ratios. According to the study, the hoop stress in PVC tubes decreases as the tube's diameter, thickness, and L/D ratio rise.

**[10] Liusheng He, Siqi Lin, Huanjun Jiang,** studied on **"Confinement Effect of Concrete-Filled Steel Tube Columns with Infill Concrete of Different Strength Grades" (2019)**. Research has been done on CFST columns. To evaluate how well the confinement effect works in CFST columns using concrete of different strengths. Several compressive loading tests were conducted on CFST columns as part of the current study. The various factors considered were the ratio of the steel tube's diameter to its thickness and the concrete's strength. A total of six CFST stub columns were created and put through uniaxial compression testing. wherein the confining pressure acting on the infill concrete, axial strength, steel tube stress condition, and confined concrete strength were all thoroughly examined. The results indicate that the most important component influencing the confinement effect is the confinement factor, which is the ratio of the nominal strength of steel tube to that of unconfined concrete. A higher confinement factor results in a greater confinement effect. When compared to high strength concrete, the low strength concrete performs better in terms of confinement and ductility.

**[11] Sangeetha P, Ashwin Muthuraman R. M, Dhivya M, Dachina G, Sai Madumathi and Janani S.** conducted research on **"Behaviour of Concrete Filled Steel Tubes." (2018).** Using ANSYS, an experimental and analytical study was conducted to compare the strength of CFST with hollow steel tube, RCC, and the bond strength between concrete and steel tube. Where multiple numbers of specimens with cylindrical shape / tubular form were cast, out of which ultimate strength was determined for as well as bond strength was observed. Both experimental and analytical observed using ANSYS. The ultimate strength of specimens i.e. CFST, RCC and Hollow Steel Tube were compared with each other, and findings are CFST have the advantages of both concrete and steel is found with enhanced behavior and average bond strength ranges between 0.7 to 1.1 N/mm$^2$.

**[12] Naveen Kumar T K, Mr. B R Narayan, Dr. N. S Kumar** conducted studies on **"Analysis of Concrete Filled Double Skinned Tubular Columns Infilled With SCC by Using ANSYS (2017)"** The goal of the current study is to ascertain the maximum load carrying capability that Concrete Filled Double Skinned Tubular (CFDST) columns with an infill of Self Compaction Concrete (SCC) can withstand. The validation technique determines the load carrying capacity of the CFDST columns using MS steel grades, such as Fe250, and Self Compacting Concrete (SCC) of different grades. The analysis is done with Ansys software. data from the ANSYS software ranged from 5% to 10% when compared to experimental data.

**[13] A.L. Krishana, R.R. Sabirova, E.P. Cherny Shovaa,** studied on **“Calculating the Strength of Concrete** Filled **Steel Tube Columns of Solid and Ring Cross-Section” (2016).** The study conducted theoretical and experimental investigations of a novel concrete filled steel tube (CFST) column design with a concrete pressed construction. Because three effects manifest simultaneously—long-term compression of the concrete mix, lateral compression of the concrete core, and its operation depending on the conditions of volume compression—the results are explained by a notable increase in the strength of the concrete core in such compressed CFST samples. The fundamental dependencies that enable such approximations of the compressed CFST final stress are also produced.

**[14] M. Pragna, Partheepan Ganesan** researched on **“Analysis of Concrete Filled Steel Tubes using Ansys (2016).”** This paper shows the load carrying capacity of Concrete Filled Steel Tubes (CFT’s) subjected to compression loading. The behavior of CFT and its various parameters effects on their behavior are carried out using ANSYS software, FEM software. By providing the behavior of Concrete Filled Steel Tube (CFT) using the modeling software ANSYS. Its more economical and time saving. Non-linear finite element analysis carried out on Concrete Filled Steel Tube (CFT) specimen by various parameter such as grade of concrete infilled, diameter to thickness ratio of the steel (D/t).

**[15] Artiomas Kuranovasl, Audronis Kazimieras Kvedaras** studied on **“Behaviour of Hollow Concrete-Filled Steel Tubular Composite Elements (2006).”** Various loading phases have been thoroughly examined through theoretical research and experimental analysis. More effective than regular CFST are hollow CFST. The element enters a stress state. by increasing the composite element's load-bearing capacity. This study examines the development of complex stress states and the behavior of hollow CFST element components under various compressed stub structural member load circumstances. The test results indicate that there is a significant variation in the behavior of single and multilayered CFST elements. In addition to having superior density and modulus of elasticity, multilayered elements are more ductile and can withstand larger loads.

## 3. Findings

- **PVC/UPVC tubes can carry significant axial loads and provide effective confinement:** Multiple experimental studies report that concrete-filled PVC/UPVC tubes increase load capacity and improves the ductility, energy absorption, and crack resistance of concrete while reducing weight and maintenance requirements versus unconfined concrete, although the level of confinement is lower than steel tubes.
- **Surface preparation matters:** Because plastics bond poorly to concrete, mechanical roughening (scratching) or chemical treatments improve composite action seen in experiments and must be represented in modelling assumptions.
- **Enhance behavior under impact:** polymer layers act as protective and energy-dissipating layers in impact scenarios.
- **Limited ANSYS-focused validation for CFPT (Concrete-Filled PVC Tubes):** several experimental studies exist, but comparatively few works perform detailed, validated finite-element (FE) studies specifically for PVC/UPVC tubes, most ANSYS FE work targets CFST or other materials.
- **Effect of tube geometry for CFPT:** parametric FE studies that sweep diameter, thickness (D/t).

## 4. Conclusion

The review of existing literature indicates that ANSYS has strong potential for investigating the behavior of CFPT under axial compression. When properly calibrated with experimental data, finite element models can reliably predict load displacement responses, confinement effects, and failure patterns. PVC confinement improves capacity and ductility but behaves differently from steel confinement simulations should quantify the magnitude of confinement increase in axial capacity and strain capacity across geometric and material variations. where environmental as well as long term effects cannot be ignored for real applications. Future studies should include the comparisons between analytical as well as experimental analysis using different geometrical properties under different loading conditions. The integration of experimental findings with advanced ANSYS modelling will provide a more comprehensive understanding of CFPT behavior and support its adoption as a cost-effective and durable structural solution.

## References

1. Kukkala Mounika, Dr. Rex, MR. Shivaramprasad "Experimental Investigation on Concrete Filled Unplasticized Poly Vinyl Chloride (UPVC) TUBES" (2025) Journal of Emerging Techmologies and Innovation Research (JETIR) JETIR2501344. https://www.jetir.org/view?paper=JETIR2501344
2. Kasun Wijesooriya, Damith Mohotti, Dakshitha Weerasinghe, Chi King Lee "Behaviour of polymer-filled–concrete–steel double-skin tubular columns under combined lateral impact and axial compression loading." (Elsevier) Structures 56 (2023). https://doi.org/10.1016/j.istruc.2023.104936
3. Qiuying Chang, Chuanhai Zhao, Lei Xing, Waqas Ahmad, Muhammad Faisal Javed, Fahid Aslam, Muhammad Ali Musarat, Nikolai Ivanovich Vatin, "Concrete filled double steel tube columns incorporating UPVC pipes under uniaxial compressive load at ambient and elevated temperature." (Elsevier) Case Studies in Construction Materials 16 (2022) e00907. https://doi.org/10.1016/j.cscm.2022.e00907
4. Aref A. Abadel, M. Iqbal Khan, Radhouane Masmoudi "Experimental and numerical study of compressive behavior of axially loaded circular ultra-high-performance concrete-filled tube columns" (Elsevier) Case Studies in Construction Materials 17 (2022). https://doi.org/10.1016/j.cscm.2022.e01376
5. Rosette Niyiroral, Ferdinand Niyonyungu, Theogene Hakuzweyezu, Elyse Masengesho, Ritha Nyirandayisabye and Jean Munyaneza. "Behavior of concrete-encased concrete-filled steel tube columns under diverse loading conditions."(2022) Cogent Engineering, 10:1, 2156056. https://doi.org/10.1080/23311916.2022.2156056
6. K. B. Manikandan and C. Umarani. "Understandings on the Performance of Concrete-Filled Steel Tube with Different Kinds of Concrete Infill." (2021) Hindawi Advances in Civil Engineering Volume 2021, Article ID 6645757. https://doi.org/10.1155/2021/6645757
7. Yong Chang Guo, Shu Hua Xiao, Shu Wei Shi, Jun Jie Zeng, Wei Qiang Wang, Hong Chao Zhaon "Axial compressive behavior of concrete-filled FRP-steel wire reinforced thermoplastics pipe hybrid columns" (Elsevier) Composite Strucutre volume 244 (2020), https://doi.org/10.1016/j.compstruct.2020.112237
8. Shahram Mohammad Askari, Alireza Khaloo, Mohammad Hadi Borhani, Mohammad Sadegh Tale Masoule, "Performance of polypropylene fiber reinforced concrete filled UPVC tube columns under axial compression" (Elsevier) Construction of Building Material volume 231 (2020). https://doi.org/10.1016/j.conbuildmat.2019.117049
9. Rajendra Khapre, Kamesh Gonnade, conducted research on "Experimental and Computational Study on Concrete Filled PVC Plastic Tubes Placed in Columns" Helix Vol. 10 No. 01 (2020), Helix E-ISSN: 2319-5592; P-ISSN: 2277-3495. https://doi.org/10.29042/2020-10-1-165-169

10. Liusheng He, Siqi Lin, Huanjun Jiang, "Confinement Effect of Concrete-Filled Steel Tube Columns With Infill Concrete of Different Strength Grades." Frontiers in Materials April (2019) Volume 6, Article 71. https://doi.org/10.3389/fmats.2019.00071
11. Sangeetha P, Ashwin Muthuraman R.M., Dachina G., Dhivya M., Janani S. and Sai Madumathi. "Behaviour of Concrete Filled Steel Tubes." (2018) Journal of Informatics and Mathematical Sciences Vol. 10, Nos. 1 & 2, pp. 297–304, 2018 ISSN 0975-5748. 0974-875X Published by RGN Publications. http://dx.doi.org/10.26713/jims.v10i1-2.1056.
12. Naveen Kumar T. K, Mr. B R Narayan, Dr. N. S Kumar conducted studies on "Analysis of Concrete Filled Double Skinned Tubular Columns Infilled With SCC by Using ANSYS" (2016) Published by International Journal of Science and Research (IJSR) DOI:10.21275/ART20183489.
13. A.L. Krishana, E.P. Chernyshovaa, R.R. Sabirova "Calculating the Strength of Concrete Filled Steel Tube Columns of Solid and Ring Cross-Section" Published by Elsevier Ltd. Procedia Engineering 150 ( 2016 ) 1878 – 1884. Doi:10.1016/j.proeng.2016.07.186
14. M.Pragna, Partheepan Ganesan. "Analysis of Concrete Filled Steel Tubes using Ansys." (2016) International Journal of Latest Engineering Research and Applications (IJLERA) ISSN: 2455-7137 Volume – 01, Issue – 09, December – 2016, PP – 71-78. http://www.ijlera.com/papers/v1-i9/7.201612182
15. Artiomas Kuranovas, Audronis Kazimieras Kvedaras. "Behaviour of Hollow Concrete-Filled Steel Tubular Composite Elements." (2006) Research Gate, ISSN 1392–3730/ ISSN 1822–3605 2007, Vol XIII, No 2, 131–141 DOI:10.1080/13923730.2007.9636429