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Flexural and Torsional Behavior of Concrete Filled Tubular Flange Girder

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Abstract - *In today's fast-growing world, new building techniques and various components are being introduced to make the building more efficient and economical. The main purpose of the study is to provide a brief overview of the unusual component called Concrete Filled Tubular Flange Girder. The purpose of the research was achieved by understanding the various research papers related to the above-mentioned topic. Research has shown how this section helps to reduce member sizes, and improve structural strength.*

Key Words: **Finite element analysis, flexural strength, rectangular concrete filled tubular flange girders, concrete confinement, composite construction, concrete filled tubular flange girder, steel girder, I section**

1. INTRODUCTION

Metal-concrete composite construction is very popular in modern construction due to its economic and structural efficiency, as well as its easy construction. Composite structures usually use composite materials of steel and concrete in the right way, where steel usually carries strong pressures and concrete that balance this emphasis on carrying heavy loads, leading to safer and more efficient structures. The high tensile strength and ductility of the metal combined with the high compressive strength and durability of the concrete result in an effective composite action. And this paper focuses on a new architectural solution called concrete filled with tubular flange girders (CFTFGs). Generally a beam when the upper flange is replaced by a steel tube filled with concrete rather than a CFTFG. The compression flange can be circular, rectangular, pentagonal etc. These components have a higher resistance to lateral torsional buckling compared to a standard steel beam of the same depth, width and weight of the metal and are therefore able to carry heavier loads than longer spans.

In recent years, CFST-filled steel tubes (CFSTs) have received increasing attention from both research and engineering communities who drive them because of their beneficial properties such as material efficiency and competitive construction costs and are therefore widely used as columns and beams. CFSTs can improve structural structural features compared to traditional stainless steel parts due to the composite action that grows between steel and concrete. This composite practice has been investigated by many researchers using experimental and theoretical methods. It has been shown that the main concrete can prevent the binding of the metal tube area and increase the stability and strength of the joint. On the other hand, a steel tube provides closed pressure to the concrete and forces the concrete into a triaxial stress state as shown in Figure 1. In addition, in terms of construction, the steel tube provides form-function concrete, thus. reducing the need for expensive temporary jobs.

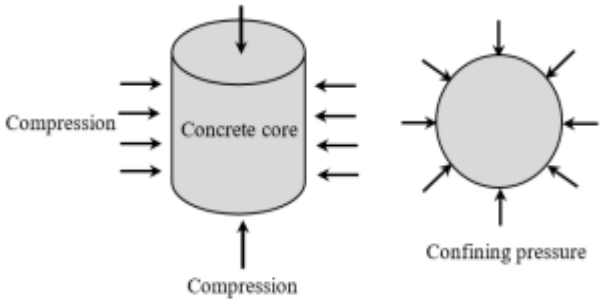


Figure 1 Concrete confined by the steel tube subjected to triaxial compressive stresses

When the upper flange of the normal I-section beam is replaced by CFST, a new type of steel-concrete composite rod is formed, known as a concrete-filled tubular flange girder (CFTFG). A number of researchers have investigated the behavior of CFTFGs in recent years and studies have often focused on members with a circular or rectangular compression flange. This study included both a finite element (FE) analysis and a large-scale study to investigate the potential for flexibility and stability. FE models include the effects of material imperfections and initial geometric imperfections, but residual stress was overlooked.

1.1 Need of study

Innovative design of various structural members is necessary for the development of the vast field of structural engineering. Thus it is important to study and improvise some of the basic characteristics like flexural behavior of the structural member.

1.2 Objective of the study

Below are the study's objectives:

1. To compare the flexural behavior of concrete filled tubular flange girder with conventional I section.
2. To study the impact of the aspect ratio of web on the flexural strength.
3. To know the behavior of concrete filled tubular flange girder under combined loading (axial tension and flexure).

2. Literature review

By studying literature reviews from various authors somewhere concluded which are follows:

2.1 Al-Dujele, R., Cashell, K. A., & Afshan, S. (2018)(Elsevier)

In this paper, the dynamics of tubular flange-filled concrete circles (CFTFGs) and tubular flanges of steel tubes (STFGs) are investigated using numerical modeling. The paper begins with a description of the finite element (FE) model that was verified compared to the available test data. A three-dimensional indirect feature model is developed with ABAQUS software. For comparative purpose concrete filled tubular flange with a hollow flange is also read. This is an easily supported belt that is subject to two fixed loads. As we know that the strength of reinforced concrete is greater than that of non-reinforced concrete so in previous studies they described certain expressions in order to obtain the strength of sealed concrete.

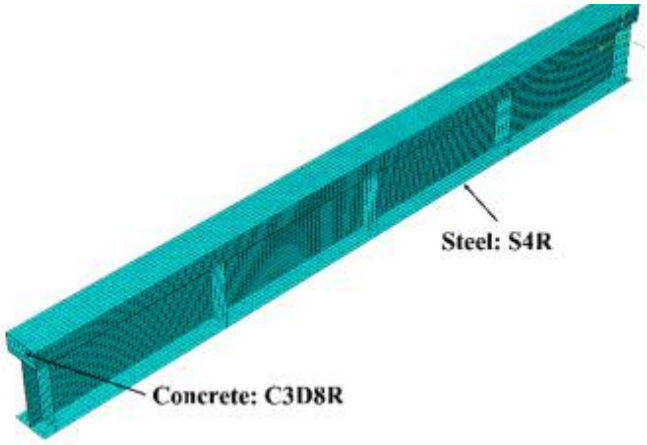
In concrete they use C3D8R (3D 8 continuous reduced integration) from the ABAQUS library and the tool used is the S4R metal (reduced 4 shell for reduced integration). They use a true strain strain curve because when there is a tension, local pressure and pressure will increase but the stress strain curve curve does not consider this effect. They also performed a parametric study and concluded that the filling concrete increases the stiffness of the upper flange, and thus allows the phase to carry more end-to-end volume compared to the steel tube flange belt and concludes based on parametric studies such as reduced aspect ratio of results web on increased flexibility.

2.2 Al-Dujele, R., & Cashell, K. A. (2021)(SAGE)

This paper deals with the behavior of tubular flanges (CFTFGs) filled with concrete under a combination of bending and tensile axial force. Research shows different combinations of loads and associated failures are identified and discussed. To facilitate this study, a finite element (FE) model is developed using ABAQUS software that can capture both non-linear geometry and behavioral material. Based on the results of a limited feature analysis, the time axial force interaction curve is introduced and a simplified figure is proposed to design CFTFGs under combined bending strength and strong axial forces.

A moderate feature model is used to study the interaction of the bending moment and the axial tension of a tubular flange band filled with concrete with varying thickness. The vertical loads are kept constant while the various axial tension levels are applied from 10% to 80% of the ultimate axial force of the steel section and the axial force interaction curve is momentary. As expected they concluded that the temporal capacity of the tubular flange filled with concrete is reduced when there is an axial tensile force acting on the steel plate. Analysis shows that the axial strength that can be maintained by concrete filled with tubular flange girder is limited and the design of the axial tensile resistance should be taken in proportion to the axial plasticity of the metal alone (the phase has reached its production capacity).

2.3 Al-Dujele, R., & Cashell, K. A. (2021)(WILLEY)



This paper aims to investigate the ultimate RCFTFG strength with strong webs under the combined effects of various levels of axial tension and moment of fine bending (sagging). Analysis of a three-dimensional indirect feature using ABAQUS was developed to facilitate research. The model is validated using available test data and then used to perform in-depth parameter research. It has been shown that the temporal volume of RCFTFGs decreases under the presence of axial tensile force in the metal line. And the strength of the RCFTFG is limited by the axial capacity of the steel only, with a small contribution from the concrete installation. Due to the lack of test data related to this numerical study it was confirmed using rectangular band data filled with tubular flange concrete under bending.

2.4 Gao, F., Yang, F., Zhu, H., & Liang, H. (2021)(Elsevier)

The lateral behavior of torsional buckling (LTB) for high-strength steel hammers (HS-CFTFBs) is tested by numerical and numerical. Five templates are tested with simple support with an uninterrupted fixed lateral load in the middle of the span. From there, both failures are controlled by flexural yielding (FY), while the remaining templates are controlled by LTB. Finite-element (FE) models are then developed and comparisons with test results show that they can test for failure methods in a reliable and accurate way, transport relationships and HS-CFTFB storage capacity. These certified FE models are used to investigate the impact of flange depth, concrete and steel of varying span lengths. The results suggest that end-time volume gradually decreases as the span length increases, especially in high-strength metal radiation. Increasing flange depth improved LTB strength but also slightly increased the value of the metal. Various examples include one with a flat plate flange, another with full or unfilled tubular flange etc. Analysis of the finished element using the ANSYS software and they obtained the results and found that the concrete tube-filled flange increases the resistance of lateral torsional buckling by 14-22% compared. so that you do not overload and increase the flexibility by 13-22%.

2.5 Hassanein, M. F. (2015)(Elsevier)

This paper represents the behavior of the pentagonal flange plate plate filled with concrete under the shaft. The geometric configuration of the phase is considered to be similar to that of a rectangular band filled with concrete, but the flange depth measurement is considered larger to reduce the local area of the web. In this paper, the basic shear behavior of these CFPFGs with thin and strong webs is investigated. Analysis of the nonlinear three-dimensional finite element (FE) using ABAQUS was performed in the parametric study, after first validating the models against the available test data. For the purposes of comparing and studying the effect of filling concrete, pentagonal flange steel (SPTGs) are also produced.

It has been found that CFPFG and SPFG of the same size have the same folding shape but with different loads. This highlights the impact of filling concrete which increases the stiffness of the upper flanges, and that is why it allows websites to carry more shear loads compared to SPFGs. It is found that a pentagonal flange belt filled with concrete and a pentagonal flange belt of steel of the same size have the same folding shape but with different loads. The flexible load of a pentagonal flange filled with concrete is higher than that of the SPFG.

3. CONCLUSIONS

Following are the conclusions from the review study:

1. Infill concrete which increase the stiffness of upper flange, and hence allow the section to carry additional ultimate moment capacity

2. Moment capacity of concrete filled tubular flange is reduced in the presence of axial tensile force acting in the steel beam.

3. Axial force that concrete filled tubular flange girder section can sustain is limited and design axial tensile resistance should be taken equal to the plastic axial capacity of steel beam alone (section reached its yield strength).

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