



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

**Volume 9, Issue 9, September 2020**

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

**Impact Factor: 7.512**

9940 572 462

6381 907 438

[ijirset@gmail.com](mailto:ijirset@gmail.com)

[www.ijirset.com](http://www.ijirset.com)

# Review on Behaviour of Hollow Sections with and without Infill under Compression and Flexure

HASAN ABDUL RASHID PARKAR, A. A. GALATAGE

P.G Student, Department of Structural Engineering, Flora Institute of Technology, Khed Shivapur Pune, India

Professor, Department of Structural Engineering, Flora Institute of Technology, Khed Shivapur Pune, India

**ABSTRACT:** A steel-concrete composite column is a compression member, comprising either a concrete encased hot-rolled steel section or a concrete filled tubular section of hot-rolled steel and is generally used as a load-bearing member in a composite framed structure. In the present study, an experiment is conducted on hollow structural steel with and without infill under compression and flexure. Composite column are structural members, which are mainly subjected to forces and end moments. The steel tube serves as a formwork for casting the concrete, which reduces the construction cost. No other reinforcement is needed since the tube itself act as a longitudinal and lateral reinforcement for the concrete core. The Concrete filled steel tube member has many advantages compared with the conventional concrete structural member made of steel reinforcement. Concrete filled steel tubes are frequently used for columns, caissons, piers & deep foundations because of their large compressive stiffness. These composite sections have the rigidity and formability of reinforced concrete with the strength and speed of construction associated with structure, thereby making them economical. In the present study, an experiment is conducted on rectangular and square hollow structural steel with and without infill under compression and flexure. The infill material used in the hollow sections is conventional concrete and light weight concrete with chemical bond and mechanical bond. Compression and flexure tests are performed on the specimens and the behavior of the specimens are plotted. The behavior of hollow specimens with and without infill is observed from the experiment also effect of bonding between the concrete and steel is obtained. The results obtained from the experimental work are compared with numerical study by Finite Element Modeling using ANSYS.

**KEYWORDS:** Hollow Sections, Finite Element Modeling, ANSYS, Compression and flexure tests

## I. INTRODUCTION

Rectangular (RHS) and square (SHS) hollow sections are often employed as bracing members in earthquake-resistant frames, for structural as well as aesthetic reasons. As part of the capacity design philosophy, energy is dissipated through critical members and components, which are expected to undergo inelastic cyclic deformations without suffering significant loss of strength. Clearly, in the case of braced frames, these critical members are the diagonal braces, for which a detailed assessment of the cyclic response is fundamental to the seismic design process. During the last few decades, several studies have been undertaken to examine the inelastic behaviour of bracing members. Earlier tests by Popov et al [1] reported that once a member buckled during cyclic testing, its compressive capacity in subsequent cycles decreased and that the axial stiffness of a specimen during tension loading deteriorated with each cycle to larger amplitude displacements. Further work by Jain et al [2] suggested that the post-buckling reduction in compressive strength could be expressed as a function of the effective slenderness of the member. More recently, Remennikov & Walpole [3] established that the post-buckling compressive capacity of steel bracing members can vary between 20% and 100% of that in the first cycle depending on the slenderness ratio of the brace, with slender braces suffering the greater reduction. Tremblay [4] found that fracture of rectangular hollow bracing members depends strongly on their slenderness ratio and, to a lesser extent, on the width-to-thickness ratio of the cross-section and the imposed displacement history. It was reported that slender braces sustained higher ductility levels prior to fracture, most likely because the strain demand in the plastic hinge reduces with brace slenderness. Tremblay's results suggest that slender braces perform well during cyclic testing, which agrees with the findings of Jain et al [2].

## 1.1 Background

A steel-concrete composite structural member contains both structural steel and concrete elements which work together. There are many combinations between structural steel and concrete. For example, a concrete slab on a steel beam with mechanical shear connectors allows the slab and beam to resist bending moment together. A concrete-filled steel tubular (CFST) column is formed by filling a steel tube with concrete. It is well known that concrete-filled steel tubular (CFST) columns are currently being increasingly used in the construction of buildings, due to their excellent static and earthquake-resistant properties, such as high strength, high ductility, large energy absorption capacity, bending stiffness, fire performance along with favorable construction ability etc. Recently, the behavior of the CFST columns has become of great interest to design engineers, infrastructure owners and researchers. Steel-reinforced concrete column (SRCC), comprising a structural steel core surrounded by reinforced concrete, is used when an exposed concrete surface is required and when concrete is to protect the steel core from fire. Two types of composite columns, those with steel section encased in concrete and those with steel section in-filled with concrete are commonly used in buildings. Under severe flexural overload, concrete encasement cracks resulting in reduction of stiffness but the steel core provides shear capacity and ductile resistance to subsequent cycles of overload. Concrete-filled steel tubular columns have been used for bridge piers subject to impact from traffic, columns to support storage tanks, decks of railways, columns in high-rise buildings and as piles. In current international practice, CFSTs columns are used in the primary lateral resistance systems of both braced and unbraced building structures. There exist applications in Japan and Europe where CFST are also used as bridge piers. Recently in Australia, Singapore, and other developed nations, concrete-filled steel columns have experienced a renaissance in their use. The major reasons for this renewed interest are the savings in construction time, which can be achieved with this method. Concrete filled steel tubular columns have been utilized in dwelling houses, tall buildings and many types of arch bridges. Steel hollow sections used as reinforcement in this composite structure. CFST columns have established an appropriate loading capacity, ductility and energy absorption capacity. The steel tube functions as the formwork for casting the concrete and hence, construction cost is reduced. There is no other reinforcement and the tube acts as longitudinal and lateral reinforcement for the concrete core. An evaluation of available experimental studies shows that the main parameters influencing the behaviour and strength of concrete filled steel tubular columns are slenderness, the diameter to wall thickness ( $D/t$ ) ratio and the initial geometry of the column.

## 1.2 Motivation

Compared to other forms of steel member, hollow sections are very effective at resisting axial loads. However, when such sections possess thin walls, they are susceptible to local buckling at high compressive strains. The onset of local buckling reduces the ductility of the brace member and may lead to brittle failure. This has been noted in a number of experimental studies on cold-formed hollow section bracing members (for example, [1] – [4]). It was envisaged that filling hollow steel sections with concrete or mortar would improve their squash load, but more importantly, it would delay the onset of local buckling and improve the member's post-buckling response. In addition, the inherent improvement in fire resistance provided by composite members may also lend this member type as a viable option in practical design situations. A large amount of research has been performed into the response of concrete-filled RHS stub columns, much of which is summarised in [5] and [6]. It was found that the presence of concrete infill eliminated or delayed local buckling of steel hollow sections, and increased significantly the ductility of the section. At certain values of longitudinal strain, the infill begins to increase in volume due to microcracking, which induces concrete confinement by the steel tube. The confining pressure is less, and the material degradation greater, for square rather than circular sections. Comparatively less research has been performed on void-filled RHS braces subjected to cyclic axial loading. Earlier experimental work by Liu & Goel [7] on the cyclic behaviour of cold-formed steel RHS bracing members filled with concrete found that the infill improved the specimens buckling, post-buckling and tensile capacities, reduced the severity of local buckling and hence delayed cracking of the steel, and ultimately increased the member's ductility. The presence of concrete infill led to the greatest improvement in performance for specimens with larger width-to-thickness ratios and smaller overall slenderness ratios, as these members are more susceptible to local buckling.

A steel hollow section in-filled with concrete has higher strength and larger stiffness than the conventional structural steel section and reinforced concrete. Composite column are structural members, which are mainly subjected to forces and end moments. The steel tube serves as a formwork for casting the concrete, which reduces the construction cost. No other reinforcement is needed since the tube itself act as a longitudinal and lateral reinforcements for the concrete core. The continuous provided to the concrete core by the steel tube enhances the core's strength and ductility. The concrete core delays bending and buckling of the steel tube, while steel tube prevents the concrete from spalling. Also concrete filled tube (CFT) columns are suitable for tall buildings in high seismic regions since concrete delays the local

buckling of steel hollow sections and increases the ductility of the section significantly. While there is a large number of studies on the behaviour of CFT columns and beam-columns. There is relatively little research reported on the flexural behaviour of concrete-filled hollow structural steel column. The structural behavior of a CFT is governed by the member strength, reflecting the fact that the load resistance is dependent not only on the material properties but also on the geometric properties of the entire member. Combining of these materials had a number of motivations; steel columns were often encased in concrete to protect them from fire, while concrete columns were combined with structural steel as reinforcement. Since past few decades, composite steel-concrete construction of column and girder is being used in the construction industry. These composite sections have the rigidity and formability of reinforced concrete with the strength and speed of construction associated with structure, thereby making them economical. The steel and the concrete element in a composite member complement each other ideally. Composite members consisting of rectangular steel tubes filled with concrete are extensively used in structures involving very large applied moments, particularly in zones of high seismic risk. Thus in present work the concrete filled steel tube columns and beams are cast and tested under compression and flexure respectively.

## II. LITERATURE REVIEW

### 2.1 Introduction

The first study of steel-concrete composite members began as early as 1908 at Columbia University. The combined material strength was not appreciated in the early days and the design concept considered two individual materials by either conservatively neglecting the contribution from one or another or by adding them separately. An early composite beam system that gained popularity was a concrete slab on steel beam with mechanical shear connectors. Later, other composite forms including concrete filled steel tube (CFSTs) construction where concrete is placed in a hollow steel member, reinforced-concrete steel (RCS) construction with RC columns and steel beams, and construction with steel-reinforced concrete (SRC) columns, became popular. SRC columns involves with steel members surrounded by concrete.

### 2.2 Experimentation

#### 2.2.1 Compression test

**Bhartesh and Sureshchandra** have conducted tests in four series for each of the two tests. Each series consists of 9 specimens which are further subdivided as short column specimens, intermediate column specimens and long column specimens, consisting of 3 specimens respectively. Series 1 and 2 the specimens are cast with concrete and series 3 is cast with No-fines concrete. Each column has cross sectional dimension as 75 mm X 75 mm, and the length of specimens varies as 300 mm, 360 mm, and 400 mm for short, intermediate and long column specimens respectively. The thicknesses of hollow section used as 1.6 mm.

**Chithira and Baskar** experimentally investigated the thirty specimens subjected to eccentric load condition with and without shear connectors. Three different D/t ratios such as 21, 25 and 29, and L/D ratios varying from 5 to 20 here considered as parameters. Out of total 30 specimens, 6 specimens were based steel tubes as reference specimens and remaining 24 specimens were CFST columns-12 with shear connectors and 12 without shear connectors.

**Patidar** presented the advantages of concrete filled steel tube member with the conventional concrete structural member made of steel reinforcement. In this study experiment load verses axial deformation of composite columns were determined. The size of the column was 140 x 160 x 1500 mm and the grades of concrete infill are M20, M30 and M40. The thicknesses of the tube were taken as 2 mm, 3 mm, 4 mm, 5 mm and 6 mm and, the D/t ratio varies from 26.67 to 80.

**Mohanraj and Kandasamy** experimentally investigated ten slender steel tubular columns of circular and square sections filled with plain, fiber reinforced and partial replacement of coarse aggregate by rubber concrete. The specimens were tested under axial compression to investigate the effects of fiber reinforced and rubber concrete on the strength and behavior of slender composite columns.

**Zhong and Lin-Hai** presented the results of axial compression test of fire-damaged concrete-filled steel tubes (CFST) repaired using unidirectional carbon fiber reinforced polymer (CFRP) composites. Both circular and square specimens were tested to investigate the repair effects of CFRP composites on them. The test results showed that the CFRP jackets enhanced the load-bearing capacity of the stub columns effectively. Enhancement of the columns' stiffness due to the CFRP jackets was also observed.

**Sakino and Nakahara** have done 5 year research on concrete-filled steel tubular CFT column system as a part of the fifth phase of the U.S.–Japan Cooperative Earthquake Research Program, and the tests of centrally loaded short columns were completed. The objectives of these tests were to see the synergistic interaction between steel tube and filled concrete and to derive methods to characterize the load–deformation relationship of CFT columns. A total of 114 specimens were fabricated and tested in the experimental phase of investigations of centrally loaded hollow and CFT short columns. Parameters for the tests were as follows, (1) tube shape (2) tube tensile strength, (3) tube diameter-to-thickness ratio, and (4) concrete strength. In determining the range of parameters, the emphasis was given on obtaining a wide range of test data for establishing a generally applicable design method of CFT column systems. Based on tests results for CFT columns with both circular and square cross sections design formulas were proposed to estimate the ultimate axial compressive load capacities.

**Huang and Yeh** experimentally investigated the behavior of axially loaded concrete-filled steel tubular CFT columns with the width-to-thickness ratios were in between 40 and 150, and proposes an effective stiffening scheme to improve the mechanical properties of square cross-sectional CFT columns. Seventeen specimens were tested experimentally to see the effects of cross-sectional shapes, width-to-thickness ratios, and stiffening arrangements on the ultimate strength, stiffness, and ductility of CFT columns.

**Ghannam** experimentally investigated twelve full scale column specimens of rectangular, circular steel filled with normal and lightweight concrete as Well as hollow sections to investigate the behavior of such columns under axial loadings and their buckling. The test results showed that both types of filled columns failed due to overall buckling, while hollow steel columns failed due to local buckling at the ends. The experimental results show that the steel tubes filled with lightweight aggregate concrete show acceptable strength under the applied load when compared to design calculations. Present work considered rectangular and square cross section steel filled with normal mix and light weight concrete also considered short columns for compression test. for special concrete no-fines concrete which is commonly termed as light weight concrete is used.

**Shanmugam and Lakshmi** have done extensive research on composite columns in which structural steel section are encased in concrete have been carried out. A review of the research carried out on composite columns is given with emphasis on experimental and analytical work. The review also includes research work that has been carried out accounting for the effects of local buckling, bond strength, seismic loading, confinement of concrete and secondary stresses on the behavior of steel– concrete composite columns. In this present work concrete filled steel tube columns are used.

### 2.2.2 Flexure test

**Zhong and Lin-Hai** et presented the results of bending test of fire-damaged concrete-filled steel tubes (CFST) repaired using unidirectional carbon fiber reinforced polymer (CFRP) composites. Both circular and square specimens were tested to investigate the repair effects of CFRP composites on them. For beams, the test results demonstrated that the repair effect was not as good when compared with that for stub columns. From the test results, it was recommended that other appropriate repair measures should be taken in repairing severely fire-damaged CFST beams, or those members subjected to comparatively large bending moments.

**Lin-Hai** mechanics model that can predict the behavior of concrete filled hollow structural section (HSS) beams. A series of concrete filled square and rectangular tube beam tests were carried out. The main parameters varied in the tests were the depth to-width ratio from 1 to 2, and tube depth to wall thickness ratio from 20 to 50. The load versus lateral deflection relationship was established for concrete filled HSS beams both experimentally and theoretically. It was conducted that because of the infill of concrete, the tested concrete-filled steel SHS and RHS beams behaved in a relatively ductile manner and testing proceeded in a smooth and controlled way. The enhanced structural behavior of the columns can be explained in terms of composite action between the steel tube and the concrete core. The predicted load versus lateral deflection curves for the composite beams were found to be in good agreement with experimental values. The predicted maximum strength of beams agreed well with the tested values. Simplified methods for the calculations of the moment capacities of the composite beams were proposed based on the mechanics model in this paper. In this present study of aspect ratio for rectangular cross section of column in between 1-2 and for square cross section of column aspect ratio 1 was considered.

**Famand Rizkalla** experimentally investigated the results of large-scale concrete-filled glass fiber reinforced polymer (GFRP) circular tubes and control hollow GFRP and steel tubes tested under bending. The diameter of the beams was ranged from 89 to 942 mm and the spans ranged from 1.07 to 10.4 m. The study investigated the effects of concrete filling, cross-sectional configurations including tubes with a central hole, tube-in-tube with concrete filling in between,

and different laminate structures of the GFRP tubes. The study demonstrated the benefits of concrete filling, and showed that a higher strength-to-weight ratio could be achieved by providing a central hole. The results indicated that the flexural behavior was highly dependent on the stiffness and diameter-to-thickness ratio of the tube, and, to a much less extent, on the concrete strength. Test results suggest that the contribution of concrete confinement to the flexural strength was insignificant; however, the ductility of the member was improved. A strain compatibility model was developed, verified by the experimental results, and used to provide a parametric study of the different parameters, significantly affecting the behavior. The parametric study covered a wide range of FRP sections filled with concrete, including under-reinforced, balanced, and over-reinforced sections.

**Yue and Laurie** investigated a series of four flexural rectangular and square cold-formed hollow structural steel sections and twelve concrete filled sections to assess the general behavior of these composite sections. The test specimens were selected to examine the effects of different ratios of depth to width and therefore of the proportions of steel and concrete in compression, and of different values of shear span to depth as related to the transfer of forces from one to the other when no direct means is provided for this transfer. The tests showed that the ultimate flexural strength of the concrete-filled sections is increased by about 10-30% over that of the bare steel sections, depending on the relative proportions of steel and concrete. The stiffness is also enhanced. In all cases, slip between the steel and concrete was not detrimental, even though shear-span-to-depth ratios as low as 1 were tested. Models are developed to predict the flexural strength of the composite section. Fully plastic stress blocks with the concrete at its maximum strength are used. The models are in excellent agreement with test results.

### 2.3 Numerical Analysis

#### 2.3.1 Compression test

**Mathankumar and Anbarasan** analysed the behaviour of steel tubular section filled with concrete CFST using finite element software ANSYS. The present study was an attempt to understand the failure load of steel tubular section filled with concrete column under axial loading for different shapes such as circular and rectangular. In this project modelling of various cross section of column has been simulated nonlinearly by finite element method. Models were loaded in a concentric axial compression, and the failure loads are to be extracted. All models to be simulated have length to diameter ratio (L/D) not exceeding the value of 4.5 to act as short column and therefore no slenderness was taken into account. Failure loads calculated by ANSYS are compared with the results obtained using AISC code of practices and EURO CODE 4. The numerical results obtained from ANSYS indicate good agreement with the theoretical results calculated by using AISC code of practice and Euro code 4.

**Kurian and Paulose** numerically investigated the deformation characteristics of composite columns by using software ANSYS workbench. This paper focuses on modeling of concrete filled steel tube (CFST) column under axial loading. In this study, three dimensional finite element models have been developed to investigate the force transfer by natural bond and the interaction between the steel tube and the concrete core of concrete filled steel tubes under loading. Both material and geometric nonlinearities are considered in the analysis. Concrete filled steel tubular columns axial capacity significantly affected with the cross section of the column, concrete's compressive strength and yield strength of the steel tubes.

#### 2.3.2 Flexure test

**Laxmi and Chitawadag** presented the ANSYS model to predict the behaviour of concrete filled steel tube to determine moment carrying capacity at ultimate point for beam. Concrete filled steel tube beams are studied and verified by the finite element program ANSYS against experimental data. The Main parameters affecting the behaviour and strength of concrete filled beams are geometrical parameters, material nonlinearities, loading, boundary conditions and degree of concrete confinement. The main parameters varied in analysis study are D/t ratio, characteristic strength of in filled concrete. The developed model predicts ultimate moment capacity for CFT beams. In the numerical analysis, circular and rectangular CFT cross sections were considered using different grades of concrete. The predicted values were compared with experimental results. Numerical analysis has shown that for rectangular CFT's a good confining effect can be provided. Moment capacity results obtained from the ANSYS model are compared with the values predicted by Lin Han (2004) and different codes such as AISC-LRFD (1999) and EC4 (1994). It is found that finite element model predicts moment capacity at ultimate point for circular, rectangular CFT's quite agree with those determined from actual experiments.

**Arivalagan and Kandasamy** experimented the concrete filled steel tube (CFST) beams and verified by the Finite Element program ANSYS against experimental data. In the numerical analysis, the cross sections of the CFST are square steel sections, and sections strengthened by being filled with normal mix concrete and quarry waste concrete. Numerical analyses have shown that for square CFST a good confining effect can be provided. This effect was

enhanced especially by the filling. Results of FE analysis and EC4 standard code show that the experimental investigation yields conservative prediction for the behaviour of CFST beams.

**Das and Vimalanandan** experimentally investigated the flexural behaviour of GGBS concrete infilled steel tubular sections. A series of tests on concrete filled square beams and hollow tube were carried out. The experimental results showed that the load carrying capacity of concrete filled steel tubes (CFST) were much higher than that of hollow tubes. The deflection was higher for concrete filled steel tubular beam. The strain was less in concrete filled steel tube. Analytical study was carried out for all types of specimen using ANSYS software. FEA results agrees well with experimental results.

## REFERENCES

- [1] T. Zhong and H. Lin-Hai Han, "Compressive and flexural behaviour of CFRP-repaired concrete-filled steel tubes after exposure to fire", *Journal of Constructional Steel Research* 63, 2007, pp. 1116–1126.
- [2] H. Lin, H. Lu, G. Yao and F. Liao, "Flexural behavior of concrete-filled steel tubes", *Journal of Constructional Steel Research*, 2004, pp. 313–337.
- [3] K. Sakino, H. Nakahara, S. Morino and I. Nishiyama, "Behavior of Centrally Loaded Concrete-Filled Steel-Tube Short Columns", *Journal of Structural Engineering, ASCE*, 2004, pp. 180-188.
- [4] C. Huang, Y. Yeh, G. Liu, H. Hu, K. Tsai, Y. Weng, S. Wang and M. Wu, "Axial load behavior of stiffened concrete-filled steel columns", *Journal of Structural Engineering*, 2002, pp. 1222-1230.
- [5] A. Fam and S. Rizkalla, "Flexural behavior of concrete-filled fiber reinforced polymer circular tubes", *Journal of Composites Construction*, 2002, pp. 123-132.
- [6] S. Mathankumar and M. Anbarasan, "Finite element analysis of steel tubular section filled with concrete", *International Journal of Innovative Research in Science, Engineering and Technology*, Vol. 05, Issue 06, 2016, pp. 11775-11779.
- [7] S. Kurian, D. Paulose and S. Mohan, "Study on concrete filled steel tube", *IOSR Journal of Mechanical and Civil Engineering*, 2016, pp. 25-33.
- [8] S. Das, G. Vimalanandan and S. Selvan, "Investigation on flexural behaviour of GGBS concrete infilled steel tubular sections", *International Research Journal of Engineering and Technology*, Vol. 03, Issue: 04, 2016, pp. 2663-2669.
- [9] Shehdeh Ghannam "Buckling of concrete filled steel tubular slender column", *International Journal of Research in Civil Engineering, Architecture and Design*, 2015, Vol. 3, Issue 1, pp. 41-47.
- [10] R. Bhartesh and B. Sureshchandra, "Experimental and numerical investigation of hollow section with and without infill under compression and flexure" *International Journal of Engineering Research & Technology*, Vol. 03, Issue 07, 2014, pp. 869-873.
- [11] B. Vijaylaxmi and M. Chitawadag, "Finite element analysis of concrete filled steel tube subjected to flexure", *International Journal of Engineering Inventions*, Vol. 3, Issue 12, 2014, pp. 18-28.
- [12] F. Tittarelli and A. Mobili, "Sustainable and durable no-fines concrete for vertical applications", *International Journal of Chemical, Environmental & Biological Sciences*, Vol. 1, Issue 5, 2013, pp. 784-788.
- [13] K. Chithira and K. Baskar, "Experimental and numerical investigation on circular CFSTs columns under eccentric load condition with and without shear connectors", *International Journal of Earth Sciences and Engineering*, Vol. 05, No. 01, 2012, pp. 169-179.
- [14] A. Patidar, "Behavior of concrete filled rectangular steel tube column", *IOSR Journal of Mechanical and Civil Engineering*, Vol. 4, Issue 2, 2012, pp. 46-52.
- [15] Bureau of Indian Standards. "Guidelines for Concrete Mix Design Proportioning", IS 10262-2009, First Revised Edition, New Delhi.
- [16] Bureau of Indian Standards. "Hollow Steel Sections for Structural Use Specifications", IS 4923-1997, First Revised Edition, New Delhi.
- [17] American Institute of Steel Construction. "Specifications for Structural Steel Buildings", AISC-2005, Chicago.
- [18] British Standards. "Design of Composite Steel and Concrete Structures", BS EN 1994-2005, Europe.



**INNO SPACE**  
SJIF Scientific Journal Impact Factor

**Impact Factor:  
7.512**

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  [ijirset@gmail.com](mailto:ijirset@gmail.com)



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details