

Development of Three Dimensional Geometry of Roof Truss

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ABSTRACT: Development of three dimensional geometry for roof truss has been analyzed and design. This paper discusses the analysis and design of 15m span of three dimensional geometry of square based pyramid shape truss with the influence of removing purlin in the form of tubular and steel structure. This paper represents the comparison of tubular and steel structure in terms of economy, weight, efficiency and deflection. This analysis and design are performed step-by-step using STAAD-PRO software considering all loads. This presents study on behavior and economical of roof truss by using spatial geometry. In this paper, the structure that is based on geometry as well as analytical and numerical representation of the relation between form and force. The results are compared and verified proves that tubular structure is economical as compared to steel structure. Therefore, tubular structure is light in weight, aesthetics, economical as compare to steel angular section. But in terms of deflection of angle section is less as compare to tubular structure. Also the pyramid shape is simple geometry for analyses and design with removing purlin gives good result by saving cost with minimum weight and deflection for large and short span structure depending on material.

KEYWORDS: Analysis and design of truss, Space truss, steel structure, three dimensional geometry, tubular structure.

I. INTRODUCTION

Space structure is light in weight, easy to manufacture and transport, flexible in workability, and requires short period for construction. Space truss is used to denote the structural system in which small linear members are arranged in three dimensions. The space truss structure as compared to plane is three-dimensional nature both in assembly and in load carrying behavior. These are used where there is need to avoid column. It consists of members joined together at their ends and form stable three dimensional structure. The advantage of space truss is their higher industrialized degree in production and construction, relative to other conventional system. Also their positive aesthetic quality and last is functional in that a space truss requires only the addition of light roofing system to enclose space. Also the collaboration between architects and engineers is being improved and simplified. Hence there are different spatial geometry developed for a roof truss. The geometry should be simple and statically determinate structure. This can be analyzed and design for angle section and hollow tubes. As the construction industry continues to evolve, innovative product and design techniques are being developed for increasing demands on both the efficiency and aesthetics of civil engineering structures. Hence, high strength, hot-rolled and cold-formed oval hollow sections called as tubular section is used. Tubular structure increases load carrying capacity, reduces the cost of maintenance, cost of painting. Tubes are of special interest to architect from an aesthetic point of view. The external surface of tube does not permit the collection of moisture and dust thus lack of corrosion. Steel is used for making structural steel shapes. Structural steel attributes compressive strength as well as tensile strength. It having high strength, stiffness, ductile properties, and toughness. It can be developed into nearly any shape. Steel is inherently noncombustible material. Hence this geometry has been designed for both sections and compared for weight, economy, aesthetics, and deflection. This is analyzed and designed considering dead load, live load, and wind load.

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II. SPACE TRUSS WITH SPECIAL GEOMETRY

As we defined space truss using different geometry, the simple geometry is pyramid with less members and designed with removing purlin. Hence it is economical as compared to others. In this, sheets are rest on members and load is transferred from members to joints. Also the load is equally distributed in three directions. This is analysed and designed for both tubular and angle section. The analysis and design of pyramid as a three dimensional geometry for space truss is for angle and tubular section with its economy and aesthetics. Pyramid roof is type of hip roof. In this, inverted pyramid is used for roof truss. It is simple geometry and statically indeterminate. There are no vertical sides or gables. Square based pyramid is easy in cutting as compare to hip. A pyramid roof is extremely resistant to strong wind. This makes it an architectural choice for high-wind areas. The slope also provides extra space for ventilation or high ceilings.

With the industrialization and development of modern world there is demand for aesthetic and efficient structure. Hence the analysis and design of such special geometry is required. After the review of different shape formation, pyramid is simple geometry without using purlin. This is simple for analysis and design using STAAD-PRO software. The development of various three dimensional geometry used for space truss depends on their stability, erection, safety, efficiency, aesthetics, deflection.

III. TRUSS DESIGN

Problem :

Geometry : 3D Square based inverted pyramid

Span : 15m

Loads : The load transfer to members in weight per meter. Hence,

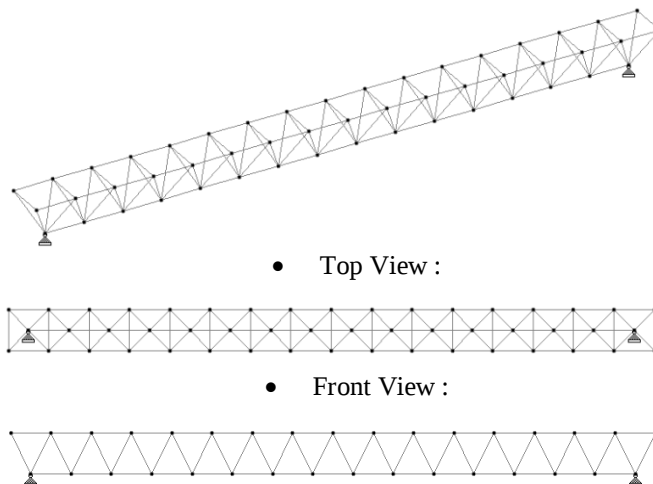
Dead Load -6.5 kN/m

Live Load -3.5kN/m

Wind Load - 3.85 kN/m

Use angular steel structure and tubular structure

- Isometric Geometry for 3D roof truss : This inverted pyramid shape is used for 15m span using angle section and tubular section. This is in three direction i.e. X,Y,Z of same length 1m. This is statically indeterminate structure.



These are the geometry of inverted square based pyramid for angle and tubular section. And the analysis and design is performed in the following order which give the property used for section and loading.

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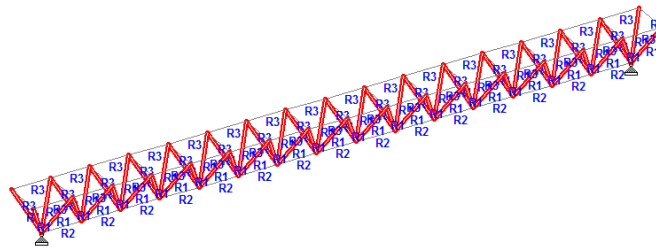
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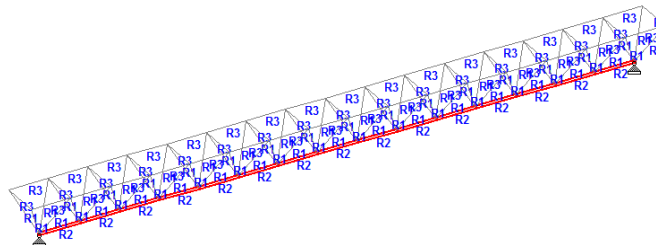
1.Angle Section : Analysis and design includes selection of property to which section should pass with satisfied result , loading gives result in terms of weight and deflection with the influence of removing purlin. These is performed on STAAD-PRO software with optimized result according to Steel Table Property and IS 800:2007 LSD.

i. Property Used : This are the property at which section passed without failure.

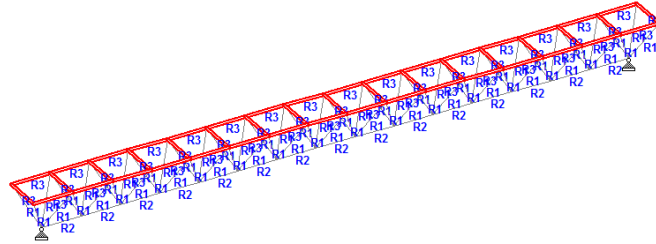
ISA 75 X75X10– This is the equal angle section with thickness 10mm provided at inclined chord given in ST. Its total length is found to be 78.38m with weight 8.430 KN.



ISA 130X130X12 – This is equal angle section with thickness provided of 12mm. Its total length is 15m and weight of 3.445 KN. These are provided at bottom and greater size than inclined.

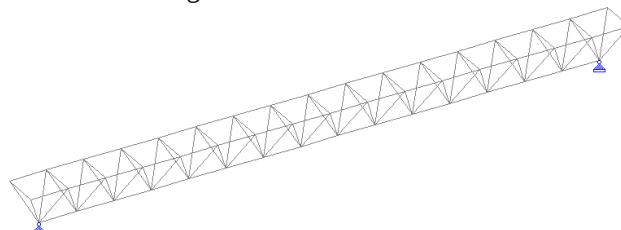


ISA 150X150X15 - These are provided as top members. These is heavily loaded hence provided with large size as compare to others. Its total length is fund to be 49m of weight 16.186 kN.



These are the section provided for design of angle section.

ii.Support : Joint 6,66 are pinned as shown in fig.



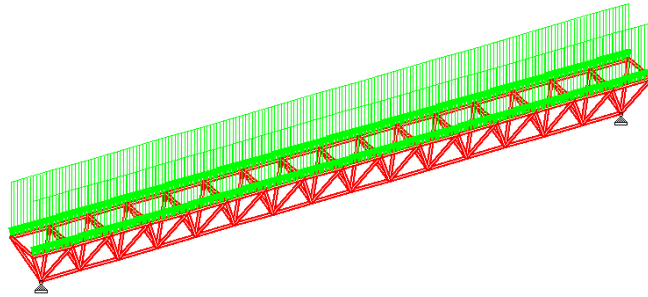
iii.Loading : These are calculated as per IS 875 Part I,II,III used for dead load , live load , wind load.

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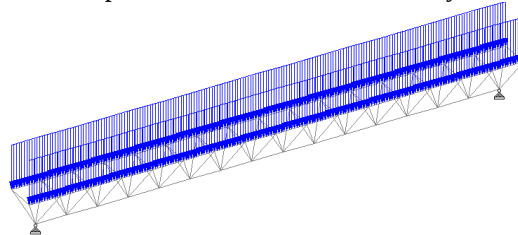
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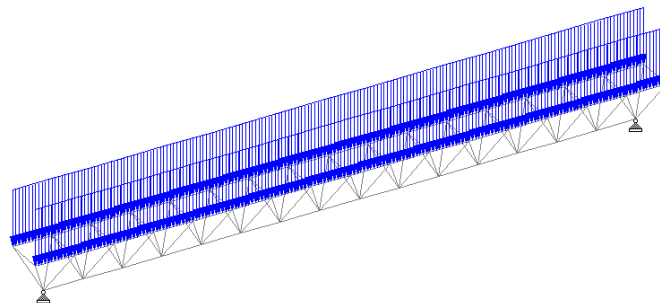
Dead Load : As per IS Code 875 Part I. Including self weight and G.I. Sheet of intensity 5.5 kN/m.



Live Load : As per IS Code 875 Part II. Intensity of 3.5 kN/m

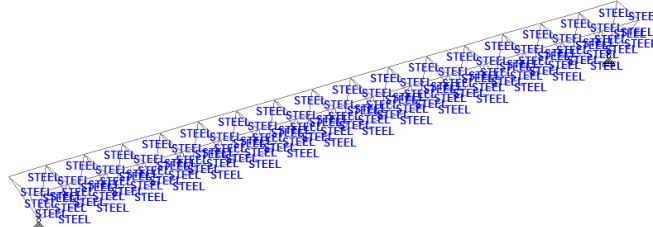


Wind Load : As per IS Code 875 Part III. Intensity of 3.85 kN/m



iv. Material : Steel is used for angle section of density 7850 kg/m^3 . It is an alloy of iron and other element, primarily carbon.

It is widely used in construction because of its high tensile strength



This is designed for 128 members and 50 joints provided with 2 supports. This design is carried out as per IS 800:2007 LSD. These is for angle section.

2. Tubular Section : These are analysed and design above geometry for tubular section. The dimensions are same hence the isometric view, top view and front view are same for this type of structure. The analysis and design is performed in following manner on STAAD –PRO Software with the influence of removing purlin to minimize weight.

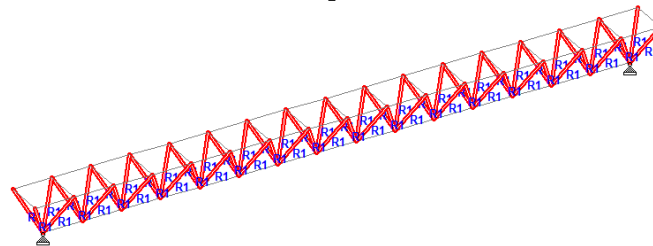
i. Property :

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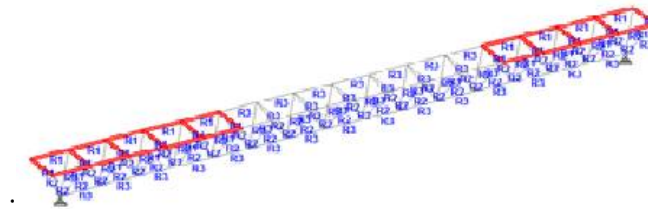
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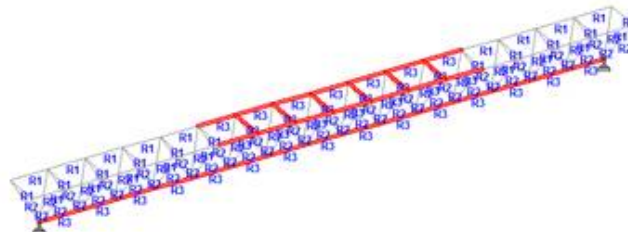
i. TUB 75X75X4.9 : These are the equal section used with thickness 4.9mm.



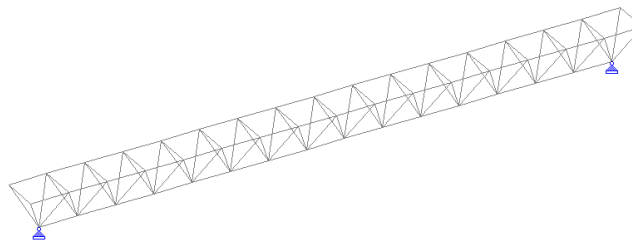
ii. TUB 132 X132X6.0



iii. TUB 150X150X6.0 :

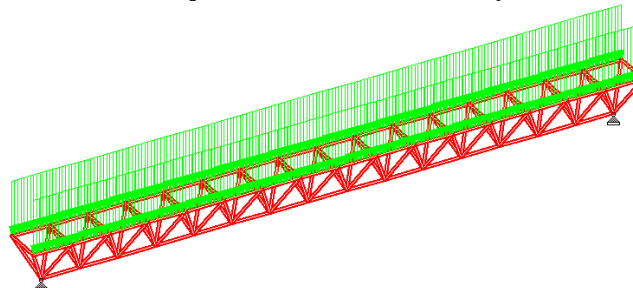


ii. Support : Two supports are provided at 9,66 and both are pinned with zero deflection.



iii. Loading :

Dead load : As per IS 875 Part I and intensity 5.5 kN/m.

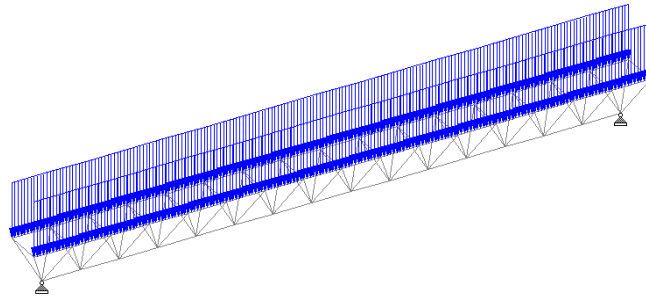


Live Load : As per IS Code 875 Part II of 3.5 kN/m

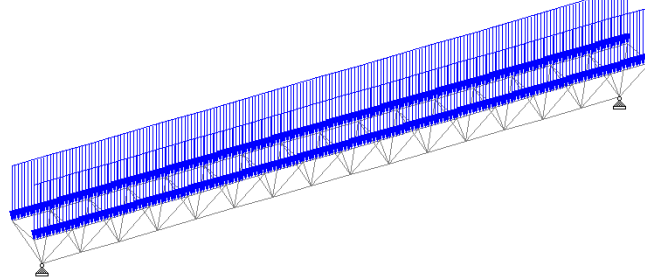
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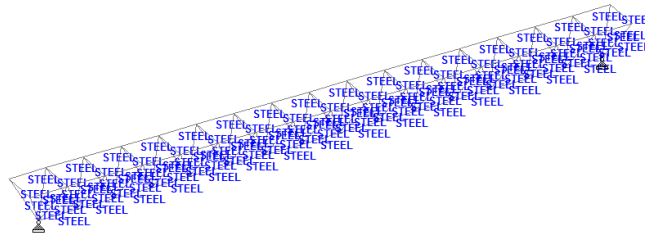
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Wind Load : As per IS Code 875 Part III of 3.85 kN/m.



iv. Material : Steel is used for tubular structure.



IV. RESULT

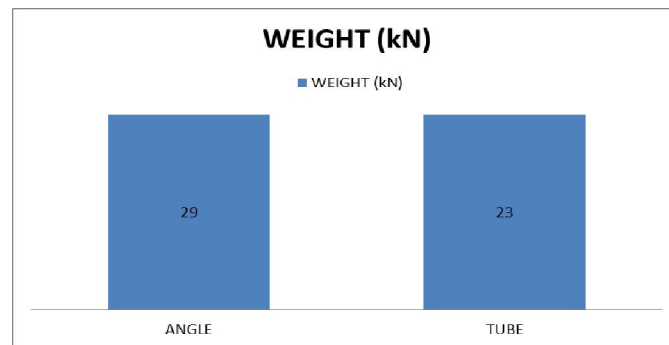
I. Result table for weight - Result as shown below that the weight of tubular structure and steel angular structure is compared and found that weight of tubular structure is less by than steel angular structure. Therefore, it is beneficial for small span truss. Hence it is economical and aesthetics structure.

SECTION	WEIGHT (kN)
ANGLE	29
TUBE	23

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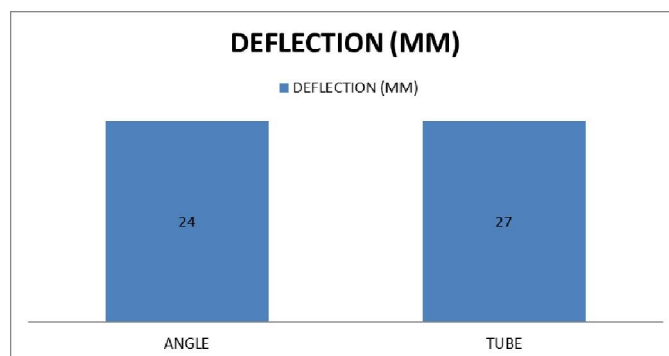
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II. Result table for Deflection- Result as shown below that the deflection of tubular structure and steel angular structure is compared and found that deflection of tubular structure is more than steel angular structure. Therefore, it is beneficial for long span with less deflection. Hence it is safety, stable structure.

SECTION	DEFLECTION (MM)
ANGLE	24
TUBE	27



V. CONCLUSION

Three dimensional pyramid shape geometry for roof truss gives good result without using purlin. It can be constructed as a steel angular structure also tubular structure. It proves that tubular structure is economical than steel angular structure. In terms of deflection, angle section gives good result as compare to tubular structure.

The propose work attempts to analyse and design of three dimensional square based pyramid geometry for roof truss with removing purlin for span15m. The material used for construction is steel for angle and tubular structure for comparing economy, aesthetics and efficiency of structure by weight and deflection. This analysis and design is performed on STAAD-PRO software. The geometry proves economical, aesthetics for roof truss by comparing weight of structure for tubular section but in terms of deflection angle section proves better than tubular. This proves that angle sections are used for large span structure with less deflection providing greater stability and safety. Also tubular structure is lightweight and require less maintenance. This is also used as a economic structure. This paper also proposes that above some geometry can be developed for roof truss. Pyramid shape proves good result as a structural engineer and architect. This paper proposes analysis and design of roof truss depends on geometry, members, construction material.

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