New truss system using rectangular hollow section

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New Truss System Using Rectangular Hollow Section

Nouveau système triangulé avec des profilés creux et rectangulaires

Neues Fachwerk-System aus Rechteck-Hohlprofilen

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1. Introduction

The rectangular hollow section steel, which is a closed section, has high torsional rigidity and shows equal sectional performance in two directions. This steel, therefore, is widely used as beam-columns members of structural frames, but the frequency of its use as long-span truss structural members is very much lower than is the case of circular hollow section steel. This is mainly because the welded joints of the chord and bracing which compose the truss are susceptible to local failures such as chord-face and chord-wall failures and punching shear. The details of welded joints are inevitably complicated to prevent such local failures, and this fact leads to fabrication complexity, structure weight increase and cost increase.

This paper proposes a new truss system (Y-truss) which has structural characteristic equivalent or superior to those of the circular hollow section steel truss, remedying the drawbacks of the rectangular hollow section steel truss and which has a nonstiffened simple joint system, reports on basic and actual-size experiments conducted to confirm the structural characteristic and shows examples of the commercial applications of this new truss system.

2. New Truss System Using Rectangular Hollow Section Steel

The newly developed rectangular hollow section steel truss system is shown in figure 1. This system has its features in the joints, as it consists in welding the chords and bracings by rotating them 45 degrees round the longitudinal axis and cutting the bracings in the shape of bird's bill. It was formerly very difficult to cut bracings in this way, but the recent development of numerical control has facilitated such cutting. This system has the following advantages. i) Since the axial loads in the bracing are transmitted as the in-plane force of the chord in the direction of 45 degrees to the axis, the flow of stress in smooth and the rigidity is high. ii) The welding length is larger than of the conventional truss system, and the strength of welded joints is higher.

3. Basic and Actual-Size Experiments on Welded Joints

Basic experiments were conducted on three types of T-joints, the new type conventional type and circular hollow section steel type, to make a comparative study of the strength of welded joints. Specimens for each having varied width ratio of bracing to chord (width of chord/width of bracing) and welding type were tested for compression and tension under static loading. For the experiments 30 specimens were used.

For both compression and tension, the welded joints of the new type truss showed higher initial rigidity and maximum load than those of the conventional type truss. The new and conventional types were compared in yielding load obtained by the general yield point method and maximum load. The yielding load of new-type truss joints was about twice that of conventional-type truss joints for a width ratio of bracing to chord of 2:1 and about 1.1 times for 3:2. The maximum load of new-type truss joints was 1.7~2.0 times that of conventional-type truss joints for a width ratio of bracing to chord of 2:1 and 1.5 times for 2:3. The difference between the two types increases as the ratio of bracing to chord increases, clearly showing the effectiveness of the new-type truss joints.

The final failure mode in tension is breaking of bracing and the mode in compression is the outward deformation of the chord local buckling in the bracing, with very little outward deformation. The new-type truss system showed stabler failure mode for both tension and compression than the conventional-type truss system. Almost no difference was noticed in deformation under load between fillet weld and butt weld. Figure 2 shows the relationship the test results which are nondimensionalized by ($\sigma_y \cdot T \cdot D$) and the width ratio of bracing to chord (d/D). The solid line in this figure are proposed a formula from the experimental results.

As shown on figure 3, actual-size experiments were carried out on high truss based on the above experimental results. New and conventional type specimens were used. As a result of the experiments, the initial rigidity, yielding strength and maximum load of the new type were found to be superior to those of the conventional type. The strength of welded joints was much higher than the yielding strength of the bracing in compression, showing that this trusses system can be designed based on the strength of truss members.

4. Examples of Commercial Applications

A gymnasium (span length 44m) and warehouse (span length 32m) were designed and constructed using this truss system. Also, an event hall (span length 108m and beam height 5.5m) has been recently designed.

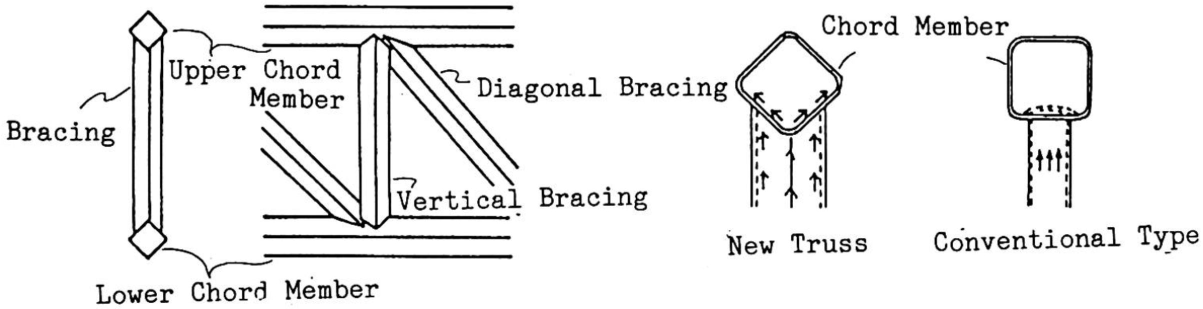

Figure 1 New Truss System

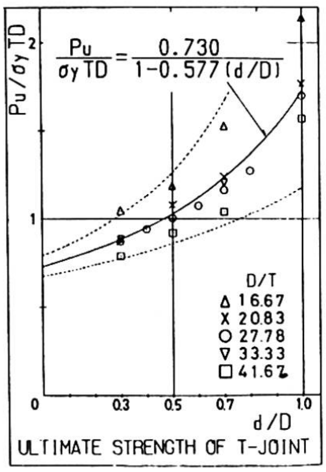

Figure 2 Ultimate Strength of T-Joint on New Truss

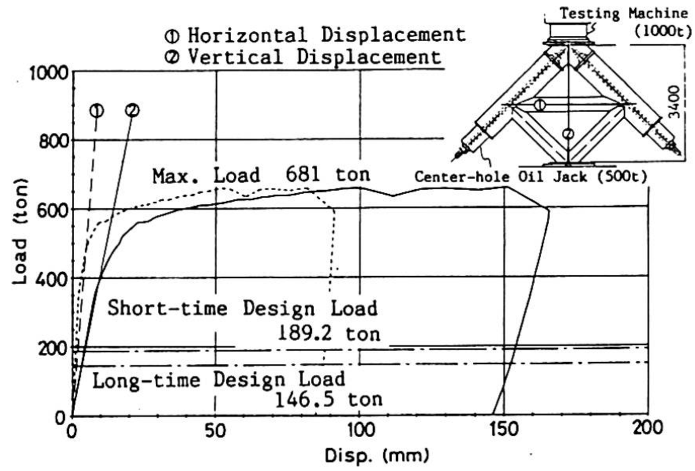

Figure 3 Load-Deflection Curves of Actual Size Experiments