High Strength Steel in Friends Arena
Savings in Weight and Cost

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Summary

Designing a roof for a large arena with many initial requirements for an outdoor feeling and flexibility for different events, etc., is a world-class challenge. This project shows using high strength steel makes it is possible to considerably reduce weight and cost.

Keywords: High strength steel, long span, retractable roof, arena, bolted, camber, cost saving, fixed roof, steel structure, optimization.

1. Introduction

Friends Arena has a capacity of 50,000 spectators for sports events. The inner level can be used to further increase the capacity, then allowing 65,000 spectators.

Sweco Structures has been responsible for the design of the steel roof from the concept stage to programed documentation, i.e. documentation of the system and the construction including the procedures for all manufacturing and installation.

2. Description of the fixed roof structure

The main load-bearing system is made up of four triangular trusses that extend 162 m across the arena, but there is also a shell effect in the roof that creates compression in the beams around the rectangular roof opening and tension in an external ring beam around the arena.

Fig. 1: Friends Arena, Main truss- Bottom chord and tension bars

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The main trusses are triangular, with two top chords made of round tubes (steel grade S460, external diameter 1067 mm). The top chords are 15,28 m apart and the framework is 16,5 m high. The top chords are fitted with end plates and screwed together during assembly. The bottom chord consists of an open, U-shaped profile with sloping sides (steel grade S690).

3. Structural elements in high strength steel

For Friends Arena we have chosen to use high strength steel selectively and where we have seen that it is possible to effectively utilize the higher strength.

For the bottom chords in the main trusses, 265 tons of steel S690 were used. The structure is permanently loaded in tension, i.e. we have no stability problems. The chosen profile was cold bent from rolled steel plates. Electrodes were chosen so that the strength of the butt welds matches the base material. The chosen U-shaped profile facilitated design of the joints as well as inspection of welds in the workshop and on the assembly site. See figure 1.

Top chords for the main trusses were manufactured from circular cold formed pipes in steel S460. The amount of steel was 904 tons. With the chosen geometry, the main trusses are within the elastic-plastic range of the buckling curve, which means that reduction of the load carrying capacity due to buckling is relatively limited.

Tension bars for the main trusses were made of steel S900. The amount of steel was 44 tons. The bars were made of double plates which were cut to size from large rolled steel plates. The end connections were made of pins in cut holes in each end of the plate. In addition to being structurally suitable, this solution is also part of the arena's aesthetic design, figure 1.

4. Savings in weight and cost

With the described measures, the total amount of steel for the fixed roof is 4 000 tons. In order to estimate the quantitative effect of using high strength steel, a hypothetical reference construction has been calculated in which the fixed roof has been built entirely of S355 steel [1]. In this analysis, the steel weight in the roof increased to 4585 tons, i.e. by 585 tons.

The alternative roof framework in grade S355 has also been priced by the contractor, Ruukki who produced and assembled the actual arena. The use of high strength steel has resulted in cost savings of EUR 2,2 million compared to use of only the conventional S355 steel. The calculations for the reference construction have been based on the same system and detailing as the actual arena.

5. Conclusions

In an international comparison, Friends Arena has a very low steel weight in relation to the size of the arena and in view of our relatively high snow loads in Sweden.

Failure to exploit the opportunities for cost savings by using high strength steel would be a waste of both money and natural resources.

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