Indoor football arena, City of Rauma, Finland

J. Outinen [1], K. Witting [2]
1 Finnish Constructional Steelwork Association,
2 Ruukki Construction

1 GENERAL INFORMATION

Client:
City of Rauma, Finland

Architect:
Optiplan Ltd, Finland

Planning of structural framework:
SS Teracon Ltd, Finland

Executive company:
NCC Construction Ltd
PPTH-Norden Ltd

Fire protection expertise:
Markku Kauriala Ltd, Finland

Processing time:
2002-2004

Kind of building:
Indoor Football Arena

Total height:
21 m

Main span of the trusses:
71.2 m

Total floor area:
7600 m^2

Figures 1 and 2. Outside and inside views of the indoor football arena

2 INTRODUCTION

When the indoor football arena in Rauma was destroyed in a fire, the new steel arena was built within a very tight schedule. The construction period of the practice arena was ca. six months. The old arena had been built using a three pin laminated timber arch anchored to the bedrock with reinforced concrete footings. In the design of the new arena, various questions were brought up: should the existing structures be utilized and how to verify the load bearing capacity of the foundations after the fire and was the bearer spacing in the old arena correct? What would be the best structural solution that would make it possible to design and build the arena within the available construction period in the autumn? The height of the arena is one of the most important factors in arenas of this type. Especially the height of the external wall line where it meets the roof is relevant with respect to the use of the arena.

3 STRUCTURE

The old concrete support wings were demolished and replaced by new steel triangles. The frame spacing was 9 600 in the old arena and 13 500 in the new arena. Correspondingly, the main span of the old hall was ca. 70 m while in the new arena it is 71.2 m. The main arches and the secondary trusses were made of tube beams. The height of the main arch and the secondary trusses is ca. 2.3 m and the distance from the bottom edge to the surface of the arena field ca. 18.7 m. The centre-to-centre spacing of the secondary trusses is ca. 5 m. A normal load bearing profiled sheet with 50% acoustic perforation was mounted on top of the secondary trusses. The perforated area covers the lower end of the arch, which ensures that normal speaking voice can be used in the arena. The longitudinal stiffening of the arena was realized with stiffening lattices made of tube beams; profiled sheet is not a good choice for stiffening in structures of this type.

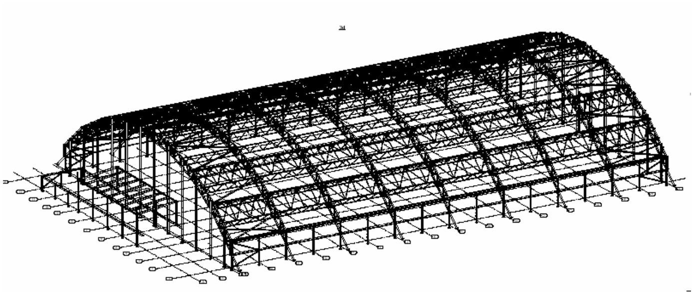

Figure 3: Structural model of the building

4 FIRE SAFETY CONCEPT

The fire classification of the arena was elaborated in negotiations and correspondence with the local rescue department. In the end, the fire safety of the arena was defined so that the building cannot collapse during the time needed for evacuation, rescue operations and containing the fire. This time is 60 minutes. The dimensioning of load bearing structures can be based either on the class defined by standard temperature-time curves or by the assumed stresses acting on the structures in a fire.

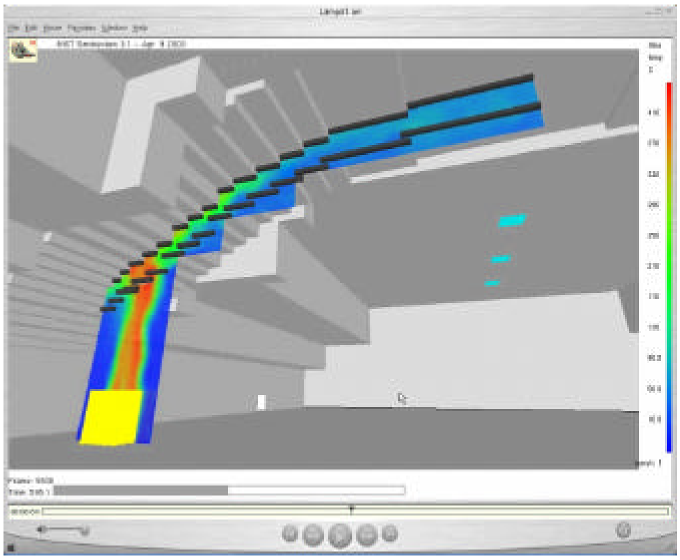

Figure 4: Results from the fire simulation. Temperatures of the structures.

Using a fire simulation realized in compliance with the grounds agreed upon with the authorities, as well as a temperature calculation for steel grades, it could be proven that the load bearing steel structures of the arena meet the functional requirements of R60, when all the steel parts of the load bearing structures are protected from the ground level up to a height of 10 m with fireproofing designed for a fire resistance of 30 minutes. About one fourth of the steel structures were fireproofed according to this, while no fireproofing was applied to the remaining three fourths (structures above the height of 10 m).

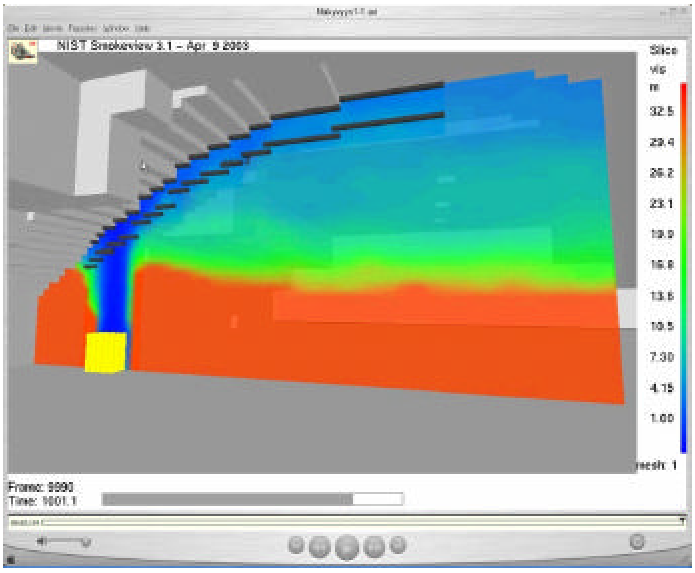

Figure 5: Simulation with FDS, Visibility in fire.

During the simulated fire, the temperatures in the upper part of the arena reached 80ºC and at a height of 2 m above the ground level the maximum temperatures varied between 20ºC and 40ºC. These temperatures will not prevent safe evacuation of the arena.

It could be concluded that the selected smoke extraction system is sufficient to ensure safe exit conditions inside the arena and makes it possible to identify the fire pocket during the initial attack. When the fire-fighters open the smoke extraction hatches and the replacement air doors about 10 minutes after the fire has broken out, the people exiting the arena will always have a smoke-free zone of at least 4 m above the ground level to exit the arena safely. The fire-fighters can also easily identify the fire pocket in the good visibility conditions. However, in order to avoid excessively long exit routes another exit door was added on the long side of the arena

REFERENCES

The National Building Code of Finland: Structural Fire Safety (Part E1, 2002)

Paloposki, Tuomas Steel structures in sports halls, VTT, Report RTE3425/00, 2000.

Reima, M., Vester, J.,Korpela, K, Witting, K., Fire simulation of the new football arena. Stell Construction Magazine No 2/2004. (www.terasrakenneyhdistys.fi)