

Sara Kulturhus

Florian Kosche
Dipl.-Ing. Florian Kosche AS
Oslo, Norway



Sara Kulturhus

1. Introduction

Dipl.-Ing. Florian Kosche AS (DIFK) took part in the design group lead by White Arkitekter AB to win the open competition for the design of the new cultural house and hotel complex «Sara Kulturhus» in Skellefteå, Sweden. DIFK further developed pre-engineering and tender documents for the structural system of the building.

The structural design is described in 25. Internationales Holzbau-Forum IHF 2019 «Kultur- und Hotelkomplex Skellefteå, Schweden – Der nächste Schritt in Europa».

DIFK has not been involved in the final detailing and construction. Site visits were restricted during the pandemic and DIFK first visited the built project in 2022.

This report describes our impressions, findings, and discussions during and after a fantastic weekend in Skellefteå.

The project is internationally recognized with widespread interest in its development.

Typically, by the time most building projects reach completion in construction, buildings have already been overtaken by the ongoing technical evolution and development, even if it was considered “cutting edge” during the planning phase.

This is seemingly not the case with the Sara Kulturhus. Even though development started in 2015, interest in the structural solutions is still high. Feedback is generally very positive. This paper discusses structural solutions as imagined during competition and pre-engineering phase with the project build. The aim is to contribute to further developments.

2. Impression

It was with mixed feelings we visited the completed project after a break of about three years. Traveling from Stockholm to Skellefteå and entering the city by bus immediately highlighted how defining the project is for the skyline of the city.

Most impressive is the façade of the hotel complex which achieves transparency and reveals the timber structure within, see Figure 1.

Upon entering the lobby, stunning spacious areas were bustling with people, participating in numerous activities. A dance class was in session in the upper mezzanine while the café near the Lobby portrayed a cosy atmosphere.

The large double height space in between the main columns of the hotel complex is simply amazing. A free open space library flanked by columns is situated on one side of the building while the hotel lobby and sprawling restaurant café sits opposite, see Figure 4 image to the right. It is interesting to see how many diverse and contradicting functions and programs are placed so tightly together, but simultaneously retains the spaciousness of the lobby.

Taking the lift inside the CLT cores is not much different than taking any lift in a concrete core. However while waiting for the lift, the experience of exposed timber surfaces is very different with their rounded cut-out corners displaying the timber layers, see Figure 7.

Entering the hotel room at the 17th level was pleasant with nice calm timber surfaces framing a full wall size view over the city. The double glass façade together with a bench in front of the window allows for a comforting distance from the height over the street level below, see Figure 5.

The theatre hall and the adjacent corridors are equally impressive, something that cannot be fully comprehended from structural-, geometry models and images, see Figure 10.

Based on visual inspection, it became clear that the implementation of the structural system follows the overall design concept developed during the pre-engineering phase. This was impressive to see and felt reassuring.



Figure 1: Main entrance and hotel complex on a grey day and at night. Photo by Brian Perktold, Mark Wojcik

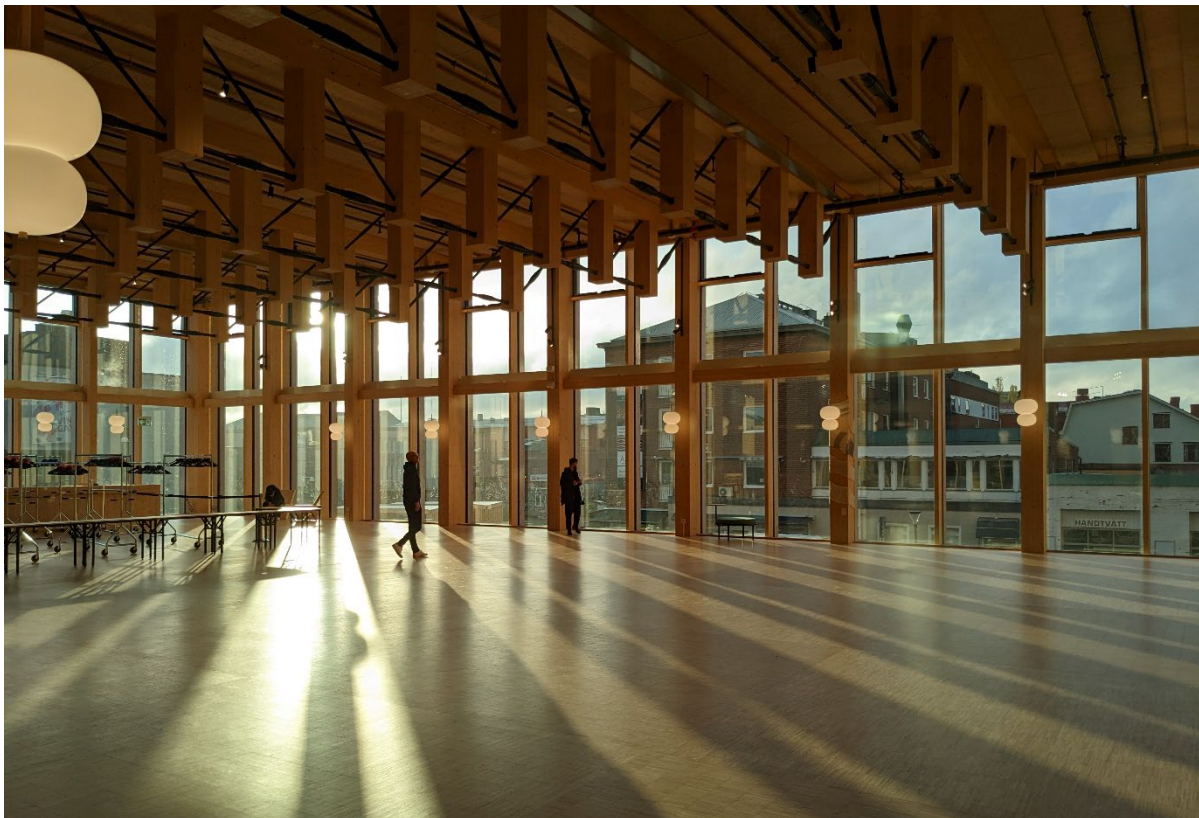


Figure 2: Second level in the lobby area. Photo by Mark Wojcik



Figure 3: Restaurant at lobby area and level over lobby area. Photo by Mark Wojcik

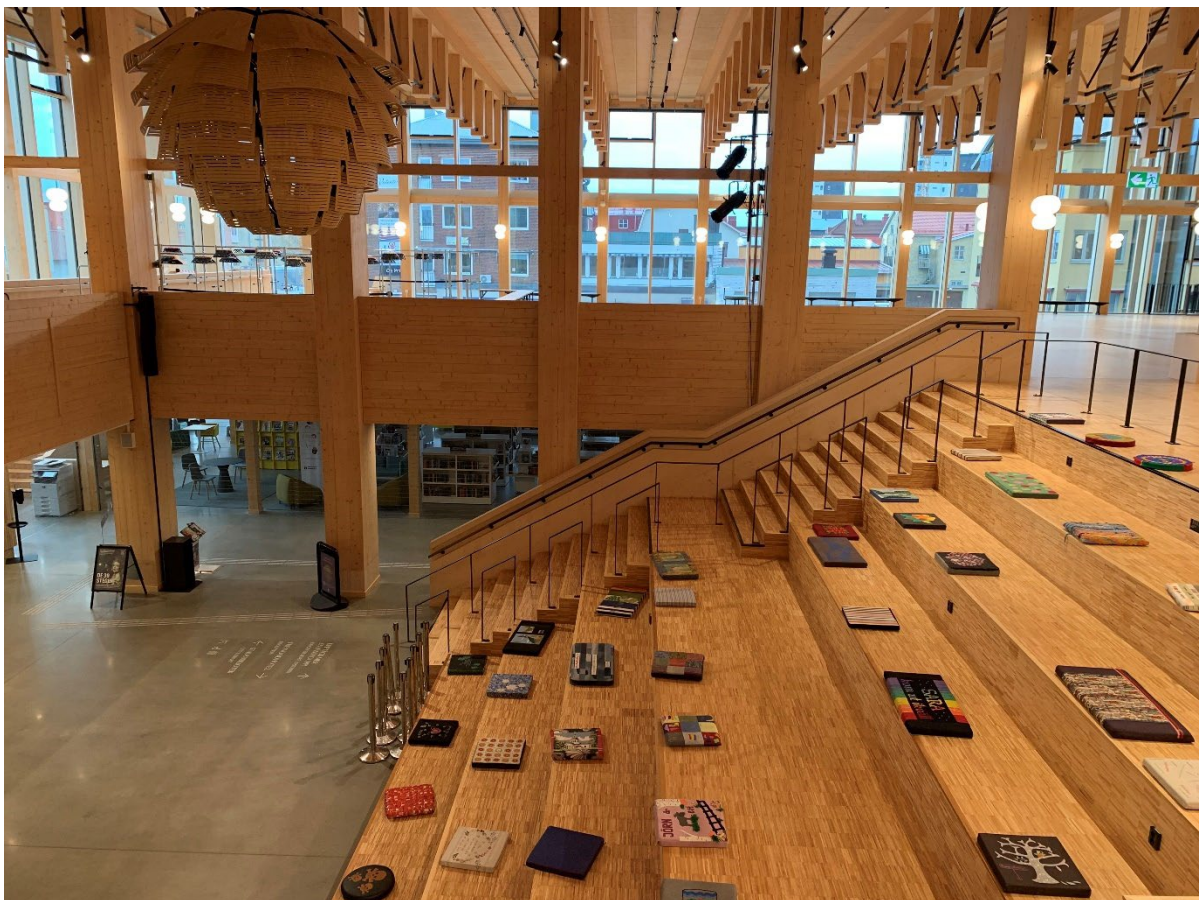


Figure 4: Atrium in the lobby area. Photo by Mattia Carioti



Figure 5: Hotel room and window with seating area, double façade and view. Photo by Mark Wojcik



Figure 6: Theatre scene. Photo by Mark Wojcik

3. Technical details

The following discussion is based on a visual inspection and the knowledge gained during competition and pre-engineering phases. It lacks detailed insight in the construction phase of the project.

3.1. Black plates

CLT panels of the main cores and related walls are seemingly connected with screwed steel plates painted black, see Figure 7. These black plates are visually dominating and clearly visible from the outside, see also Figure 1.



Figure 7: Black plates connecting main core CLT panels. Photo by Mark Wojcik

It appears that the main purpose of these plates with their tightly spaced screws is to transfer shear forces between adjacent CLT panels. The narrow spacing between screws may make the connection prone to block shear failure.

It was demonstrated during pre-engineering that typical screw-based connections, where the CLT panels would be continuously screwed together along their edges, would be sufficient for load transfer between CLT panels, see Figure 8. This could allow for a more discrete, continuous load transfer with improved fire resistance. Less screws, but of larger diameter, might have been necessary compared to the installed solution. Considerations regarding execution might have prevented other solutions to be chosen.

Other projects will consider using CLT panels for lateral load bearing and effective solutions will evolve further in the future.

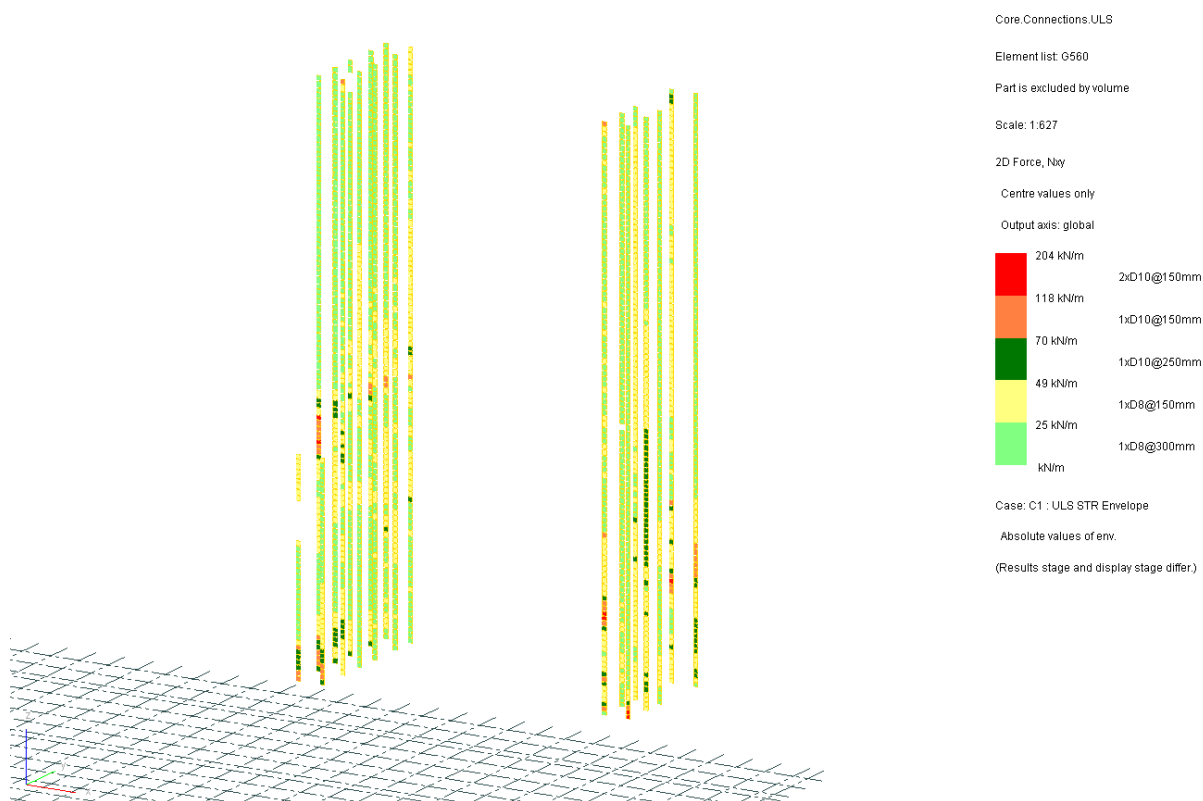


Figure 8: In-plane shear forces along the CLT panel edges of the main cores and corresponding capacity $f_{v,0,Rd}$ (1) with for example ASSYplus VG 4 8.0/10.0 with screw union $< 45^\circ$ to replace black plates.

3.1. Wind induced vibrations

Wind induced vibrations were a major concern during the pre-engineering phase due to relatively low stiffness, low weight and uncertainty regarding structural damping properties. Further, design standards propose diverging design rules. This topic deserves further investigation and research to develop a similar experience base as available for more traditional high-rise structures.

The 19th floor features a restaurant area. At this height in the tower, wind induced vibrations can be occasionally felt according to restaurant staff.

3.2. Trusses

Trusses with spans up to 19 m span over the lobby areas to achieve large column free areas, see Figure 4.

These trusses were given their distinctive design in the competition phase. Structurally, all components that carry compression are made of timber. Components that carry tension are made of steel. The structural idea was to avoid tension connections to the timber in favour of compression connections by bearing contact. To this purpose, custom made details were developed where the steel parts would be prefabricated and assembled before being connected to the vertical members and upper girt made of timber. The typical connection detail of the upper girt, see Figure 9, would then allow to adjust the length of diagonals by sliding in PL1 and PL2. After the geometry is adjusted in a jib, welds a2 in Figure 9 could be placed and the truss would be ready for transport to site.

The installed solution is shown in Figure 10. It consists of extensive dowel connections with steel rods where every rod can be adjusted individually.

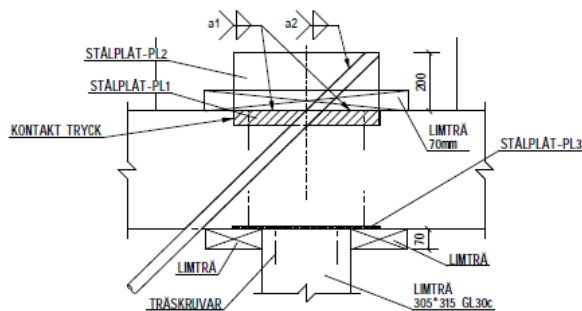


Figure 9: Technical detail for connection of vertical and diagonal to the upper girt of the truss in the lobby area, DIFK



Figure 10: Hybrid trusses over lobby area. Photo by Mark Wojcik

3.3. The brace

The author of this report supports the combination of different materials and structural systems, either with the purpose of optimization, for aesthetical reasons or any other reasonable argument that improves the structural system within its architectural context. The author has suggested several combinations of materials during competition phase and pre-engineering of this project that might be controversially discussed. These discussions do not necessarily lead to one possible answer.

Figure 11 left image shows a publicly visible hot dip galvanized steel rod cross-bracing in a predominately timber building. No other similar items have been found elsewhere in the building. It penetrates a timber column eccentrically and connects likewise to the adjacent columns. Further, it obstructs the CLT wall which could be suitable for shear transfer and possibly could replace the cross brace. It can be argued that a timber cross brace would have been more obstructive to the CLT wall but was avoided.

3.4. The truss grid

Figure 11 right image shows irregular positions of the characteristic truss verticals. Minor geometrical changes could have led to a more regular appearance. This will probably only be noticed by specially interested visitors.

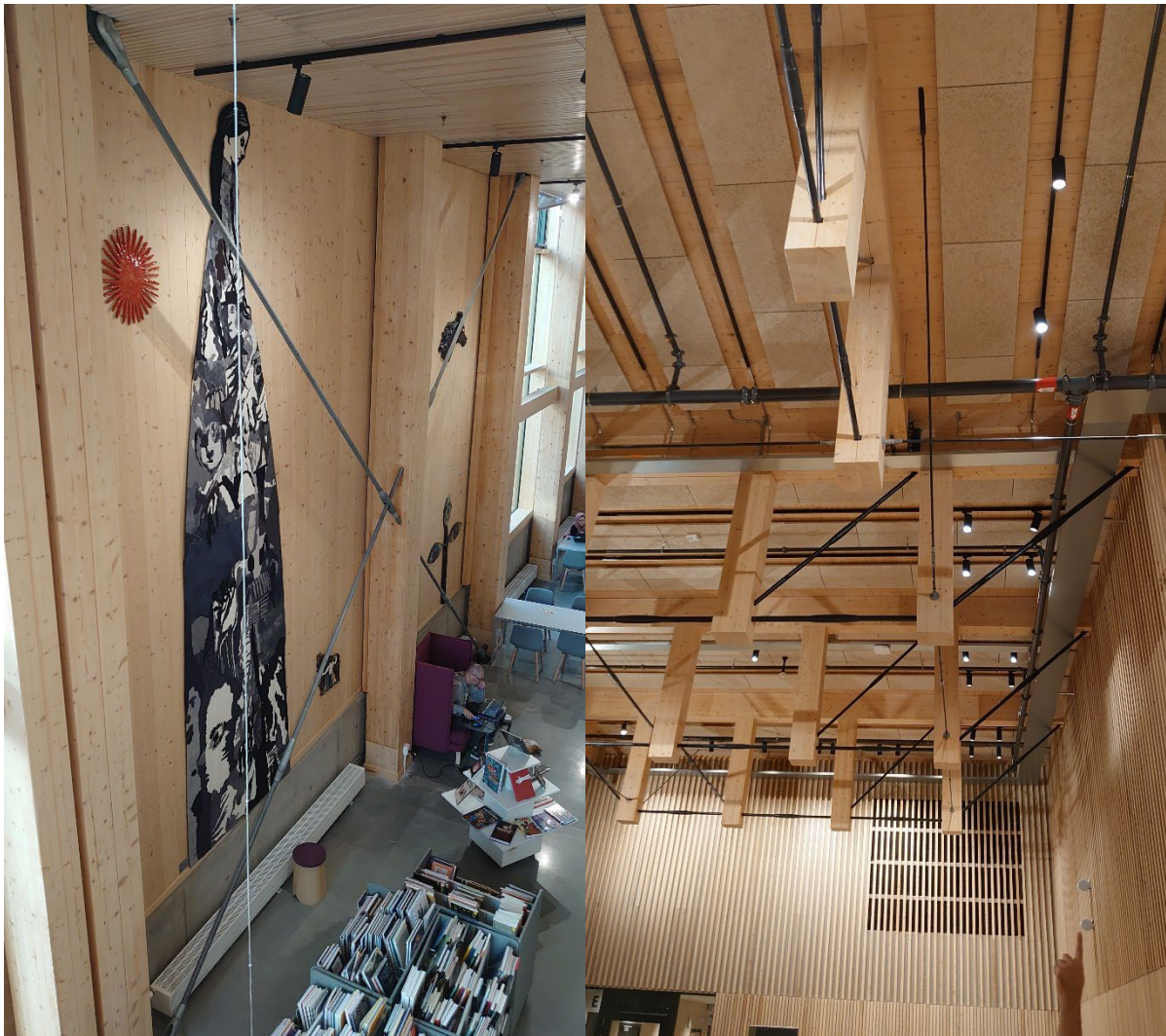


Figure 11: Steel brace in western façade and truss grid towards the support program. Photo by Florian Kosche

3.5. Detailing for technical systems

The installation of hidden technical systems in CLT walls or slabs is complicated. Unlike in dry walls, stud walls or cast concrete walls, conduits cannot be as easily integrated or later modified.

Precise geometry planning between CLT designer and all technical systems designers would be required at a design stage where the technical systems normally are not yet sufficiently developed.

Effective methods would need to be developed to integrate conduits for technical systems inside CLT elements either during fabrication of the panels or using cut outs, milling and coverings after building of panels.

Though it is easy to add installations to CLT structures on the outside by screwing, nailing or even gluing, a consistent aesthetic expression should be sought after.

Access for the maintenance of the bathrooms in the hotel modules, which is integrated into the corridor walls seems to work very well.



Figure 12: Typical implementation of technical systems. Photo by Mark Wojcik

4. Outlook

This project has been pushing boundaries in terms of functional complexity, use of CLT as structural core material and modularized construction to mention some. It will be a reference for fire design of larger timber buildings.

Substantial new knowledge in high rise timber design has been gained during the process. The project shows how excellent modern functional architecture can be achieved with large timber structures. Further, it has triggered a more thorough understanding of the environmental challenges we are facing.

All in all, the experience of the building is very positive and a visit is highly recommended.