



## Stuttgart 21 Main Station – Shape Development and Modelling of the New Station Hall

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### Summary

The core of Stuttgart 21 is the new underground station with its characteristic "light eyes". The railway tracks are rotated against the existing terminal station by an angle of 90 degrees, which means they will be oriented transversely across the Stuttgart valley. This underground station is designed as a reinforced concrete shell structure, in such a way that the concrete shell is always in compression. Its "green cover" forms the link to a new municipal district on the location of the current platform area. This paper describes the development of the shape of the shell structure, from a first soap membrane model over suspended chain models and digital CAD models to discrete finite element analysis models. The creation and modelling of the system, as well as the special calculations required are explained in some detail.

**Keywords:** Stuttgart 21, concrete shell, underground station, shape development, FEM analysis

### 1. Introduction

The Federal German Transportation Network Planning of 1992 (Bundesverkehrswegeplan) describes the urgent need for the new development and extension of the railway section between Stuttgart and Ulm, both for long-distance and regional transport systems, in the context of the European centres of Rotterdam-Rhein/Ruhr-Rhein/Main-Paris-Munich-Vienna-Budapest. This railway section is one of the busiest within Germany, and as traffic is expected to further increase it will become a bottleneck in the European high-speed network. Today's terminal (dead end) station is regarded to be a restriction for the future development of Stuttgart railway junction, especially as it will not be able to cope with the projected total of up to 300,000 passengers per day within the greater Stuttgart area with its 3.4 million inhabitants.

Eighty years after the completion of what was an innovative transport node in its day, there is now the opportunity to realise a new vision: The reclamation of 100 hectares of landscape space by building an underground connection to the European high-speed network in Stuttgart in the form of a new through station with 8 tracks that is oriented transversely across the Stuttgart valley.

After determination of the line of the tracks in plan and elevation, taking into account all criteria such as the presence of underground mineral water deposits, existing local rail, tram and metropolitan rail systems, culverts, the Nesenbach watercourse and more, an architectural competition was held for the core of the "Stuttgart 21" project, the new railway station.

The competition winner was a joint venture led by architects Ingenhoven Overdiek from Düsseldorf, whose design proposed a concrete shell roof with circular "light eyes" providing natural lighting to the platforms [1]. The consultant for the form finding process was Professor Frei Otto, Warmbronn, supported by structural engineers Happold, Bath and in the second phase of the