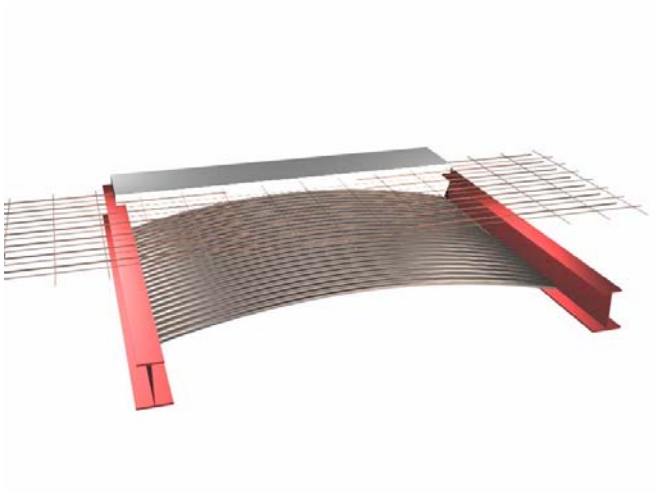
ARCH DECK

TRAPEZOIDAL ARCHED COMPOSITE FLOORING SYSTEM



TECHNICAL DOCUMENTATION

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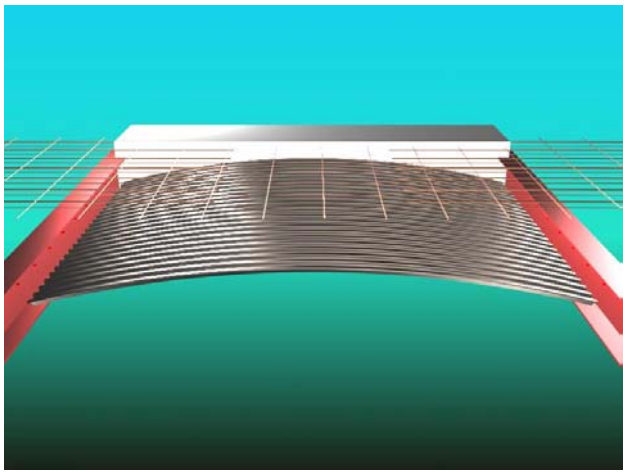
1. General Description – design philosophy:

The Arch Deck System is a composite flooring system for building and industrial construction. It links the concept of the Slim Floor Ceiling (i.e. composite floors with an integrated steel girder paired with lower overall floor thickness and integrated fire protection) to the concept of the self-supporting trapezoidal arched sheet.



Representation of the construction principle, top view

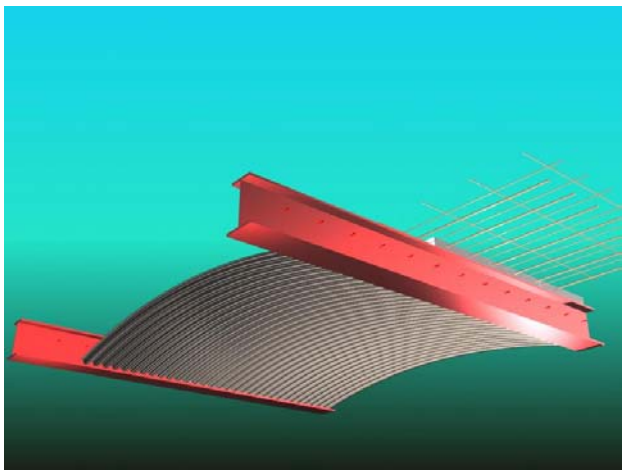
The trapezoidal arched composite flooring system consists of steel girders placed with a spacing of approx. 4 to 6 m and trapezoidal arched sheet elements resting on their bottom flanges in the fields in between. They serve as bearing shuttering for the concrete on the ceiling. The final result is a concrete arched ceiling. Thereby a continuous reinforced concrete slab of tapered cross-section, beside the steel girders, simultaneously serves as top flange of the composite beams. As the dead load of concrete is compensated by the trapezoidal arched sheets, the concrete slab need only be calculated for supposed finishing elements and the actual live load.

The extremely tapered shape of the floor slab results in a minimized bending moment of the span. Thus an overall sheet thickness of 6 to 8 cm on top of the trapezoidal arched steel plate and the required minimum reinforcement for compensating the span moments are sufficient. On the other hand an adequately large concrete cross section is available for the moment at the support. Compressive forces of the concrete are compensated by direct attachment of the steel girder web, tensile forces originating at the upper part of the sheets are compensated by a corresponding reinforcement. Due to the relatively large lever arm, minimum reinforcement is sufficient in this case as well.

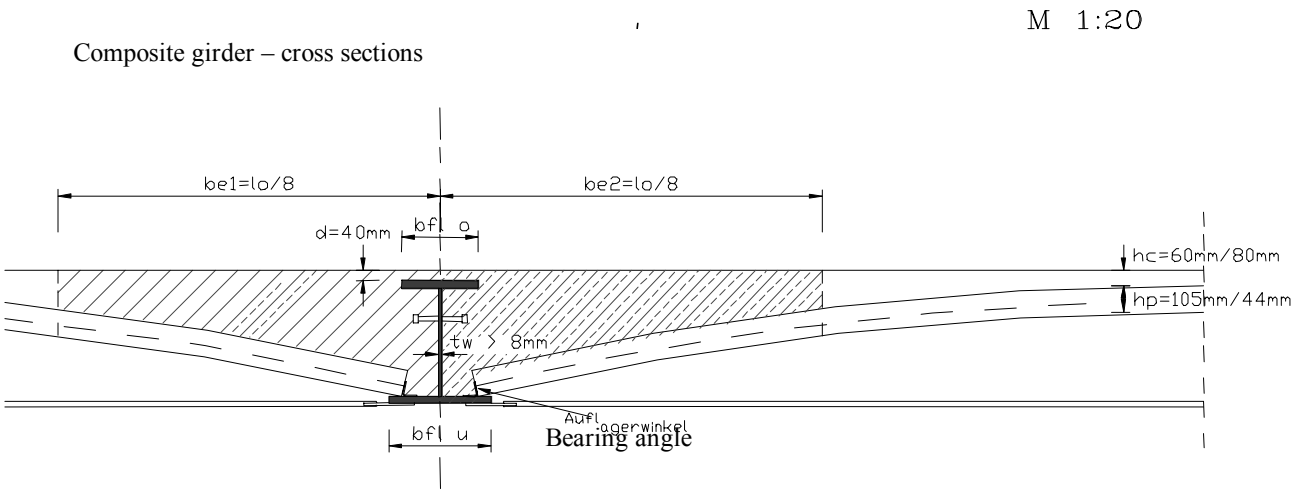
As the head bolts required for securing the necessary compound effect are located on the steel girder web, the concrete cover of the girder top flange can be reduced to the minimal dimension (approx. 4 cm) required for fire protection resp. application of the top layer of reinforcement. Compared to conventional composite floors this results in reduced overall height of the trapezoidal sheets, resp. the reinforced concrete slab elements.

Generally no additional measures for fire protection are necessary, as the heavy concrete mass beside the steel girder creates high fire resistance of the composite girder.

Representation of structural design, underside view



2. Picture 1: cross section of a trapezoidal arched composite flooring system



3. Advantages to conventional construction method:

- Larger spacing of girders allows construction without beams. Thus less single components are required and speedy assembly is facilitated.
- Due to the omission of usually required temporary supports, savings in scaffolding and working hours are achieved.
- Shorter overall construction periods, as below floor areas are immediately accessible for further construction work.
- Placing of concrete for the composite girder and the ceiling in one working process.
- No retouching necessary, i.e. closing assembly recesses at connection of girders and columns etc.
- Integrated fire protection for steel girders.
- Finished soffit, also available in color.
- The tiebacks required in the stage of construction may stay in the final stage and be utilized as suspension for fixtures or lighting.

4. Application areas:

On the one hand the radius resp. arch rise of the trapezoidal arched sheets is determined by the overall height of the steel girder and the concrete cover on top of the girder, on the other hand by the concrete cover on top of the crown at midspan. This results in optimal arch rise/span ratios from 1/15 to 1/20.

Basically the span width determines the overall height of (composite) steel girders. Thereby two criteria have to be considered:

- Overturning stability of girders in concreting condition and
- deflection of girders in concreting condition (in case they are not supported while concreting).

Comparative analyses under above conditions rendered economical solutions for column grids with

- girder span widths from 8 to 12m and
- arch span widths = spacing of girders of 4 to 6 m.

Compared to conventional floor systems the advantages of the Arch Deck System have proven to prevail, particularly with increasing load capacity ($p \geq 5{,}0 kN/m^2$).

5. Table 1: dimensions of trapezoidal arched composite flooring systems with selected column grids

Load capacity 5.0kN/m^2	
Grid pattern 9x5m	**Grid pattern 12x6m**
Overall floor thickness = 40cm	Overall floor thickness = 52cm
Girder: welded profile Overall height 360 mm Weight approx. 95.5 kg/m respectively 19,1 kg/m^2	Girder: welded profile Overall height 480 mm Weight approx. 189 kg/m respectively 31.5 kg/m^2
Dowelling Ø 19x75 e=350mm Starter bars (per side) 1.8cm^2/m	Dowelling Ø 19x100 e=300mm Starter bars (per side) 1.8cm^2/m
Arch rise f=265mm f/s=1/19	Arch rise f=375mm f/s=1/16
Trapezoidal sheet TR 105/1.1mm	Trapezoidal sheet TR 105/1.25mm
Ceiling concrete C 30/35 0.208m^3/m^2	Ceiling concrete C 30/35 0.246m^3/m^2
Floor reinforcement approx. 5.1kg/m^2	Floor reinforcement approx. 7.9kg/m^2

By means of corresponding supplementary measures for the limitation of dead load deflection in the stage of construction even larger spans and wider spacing of trusses are feasible. For a reduction of the concrete cubature around the springing of the arch hollow blocks may be inserted. A further reduction of floor weight can be achieved by applying light-weight concrete.

6. Executed project

Placing the trapezoidal arched sheets

Trapezoidal arched sheets before concreting

Placing of ceiling concrete

Soffit of finished floor right after concreting