

Annen Headquarters

Prof. Dr. Yves Weinand



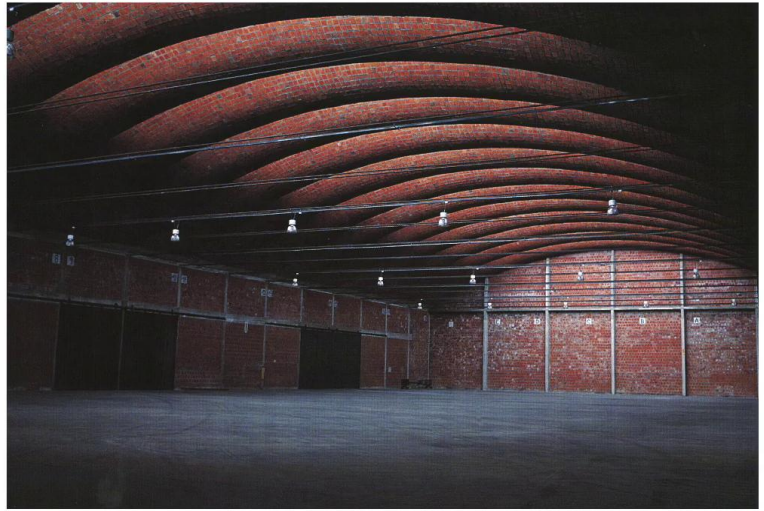
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■ Advanced Timber Plate Structural Design



I would like to present you now the Annen Headquarters, which is the building which made possible the technology transfer from all case studies, which have been shown before, at the building scale. It is a project which is inspired by [inaudible 00:00:25], the famous Paragon engineer, and its double curved walls.

Notes

Summary



0m 04s

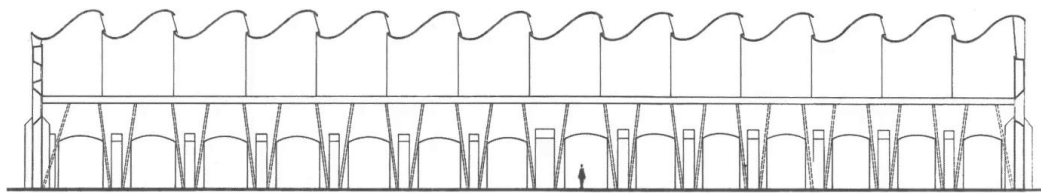


fig. 152

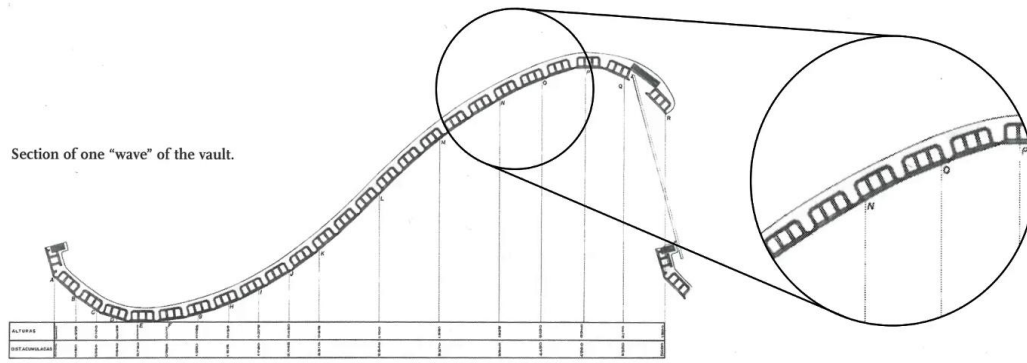


fig. 153

Section of one "wave" of the vault.

■ Advanced Timber Plate Structural Design

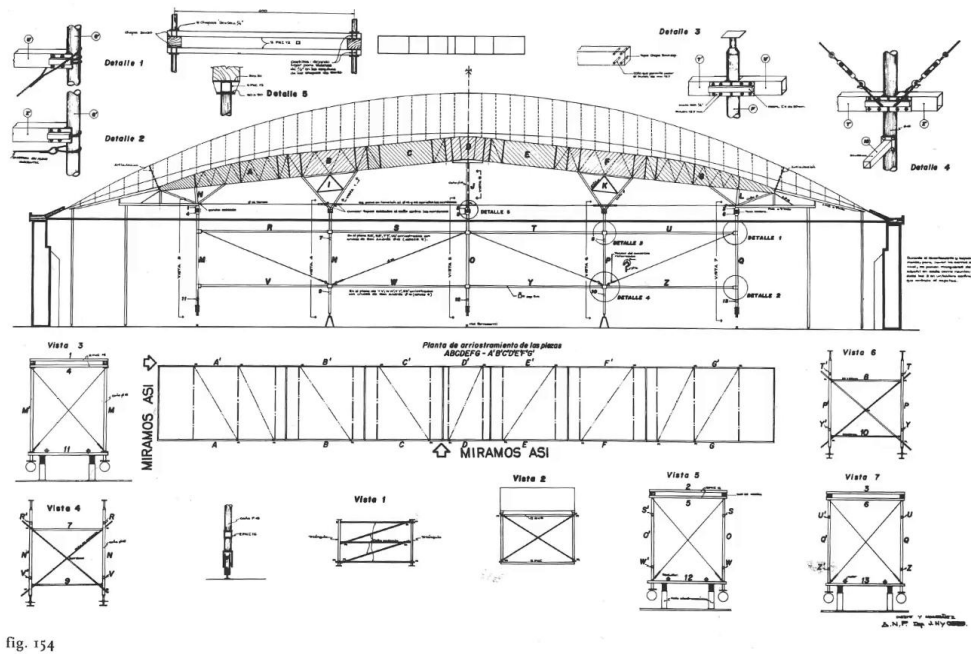
The Annen project consists of 23 arches, all of different forms, which have a span of 23-54 metre.

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0m 31s



Advanced Timber Plate Structural Design

It's a double curved shape of walls.

Notes

Summary





- Lamibois hêtre
- 40 mm d'épaisseur

| ρ_k | densité | 730 | kg/m ³ |
|------------------|----------------------------------|--------|-------------------|
| $E_{0,05}$ | module d'élasticité | 12 200 | MPa |
| $f_{m,0,flat,k}$ | résist. flexion à plat | 75 | MPa |
| $f_{v,0,edge,k}$ | résist. cisaillement sur chant | 7.8 | MPa |
| $f_{t,0,k}$ | résist. traction // sur chant | 51 | MPa |
| $f_{c,0,k}$ | résist. compression // sur chant | 53.3 | MPa |

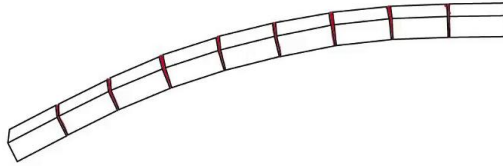
We are using LVL panels made out of [inaudible 00:00:49] project.

Notes

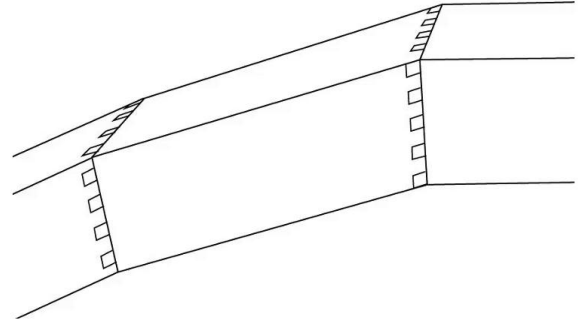
Summary



Two different constructions methods



- Briques terre cuite env. 8 cm
- Element identique répété
- La courbure est reprise par le mortier



- Caisson de bois, env. 60 cm
- Chaque caisson est unique
- La courbure est reprise dans les joints

■ Advanced Timber Plate Structural Design

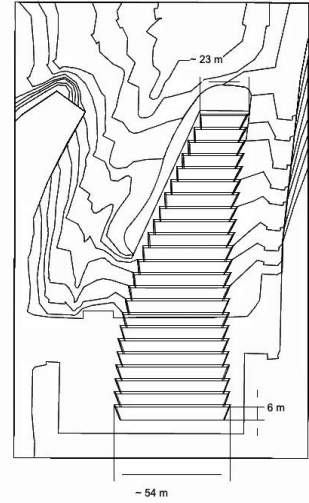
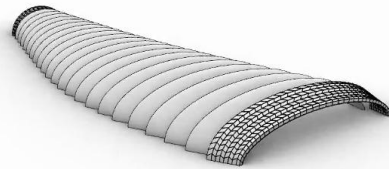
As it has been shown before, different case studies allowed us to first seed assembly sequences. This has been developed in detail earlier.

Notes

Summary



0m 51s

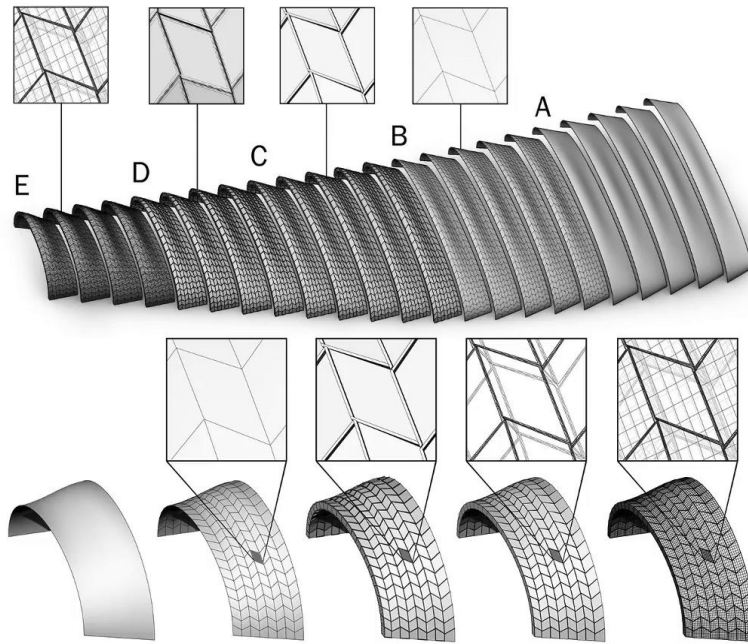


We finalised, brought up boxes, which were only attached by integral mechanical attachments. We also had fabrication constraints prototypes, as shown here. Improvement would be proposed after assembling boxes at IBOIS, and the assembly pattern would be slightly modified. The target surface would need to be subdivided.

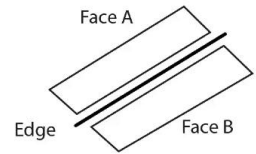
Notes

Summary

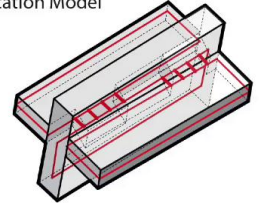




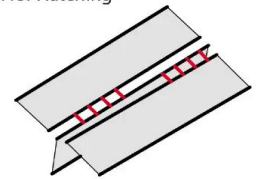
Mesh



Fabrication Model



Model for Hatching



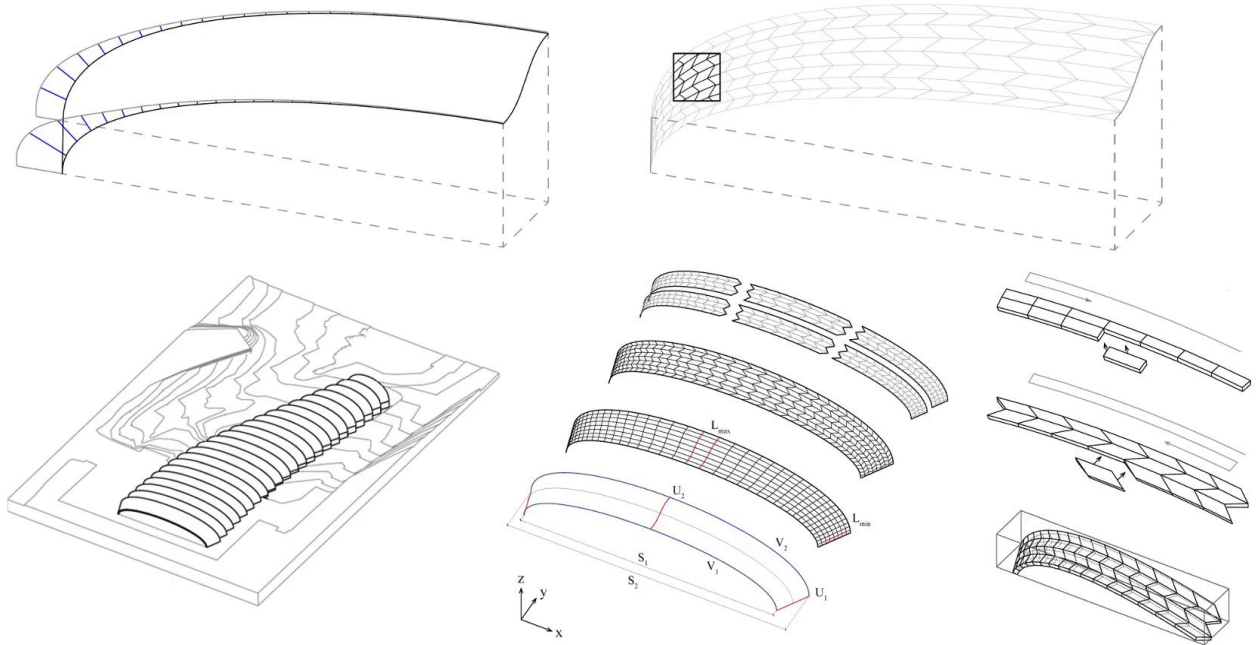
The discretisation process is very important. In this case, the discretisation process is directly linked to the assembly process, meaning that the rendering doesn't only run on the surface, but describes precisely the shape of every box, which the vault is constituted of.

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1m 30s

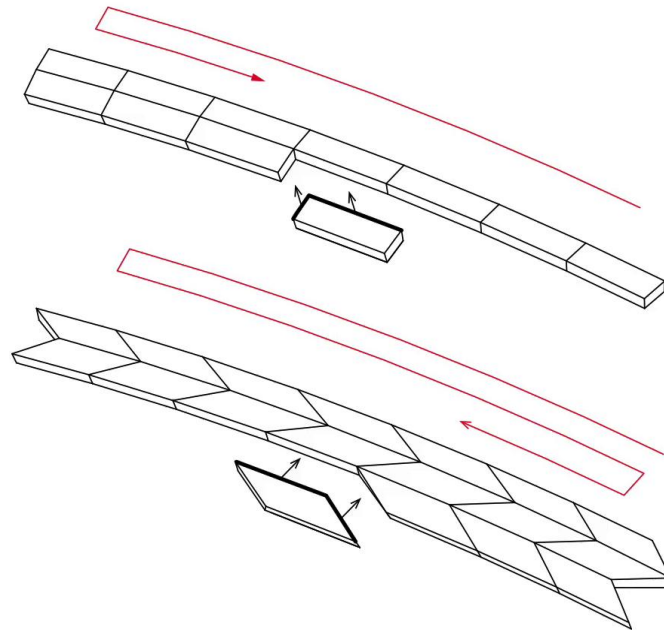


This means that also the assembly, so you can test to be discretised. We would like to insist on the fact that the structural engineering investigation should also tackle those assembly sequences and see how they could be modified.

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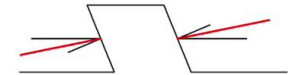
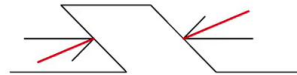
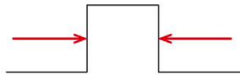
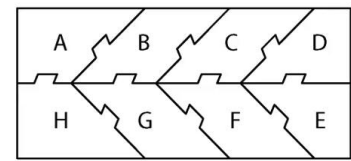
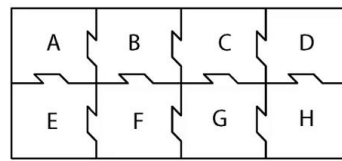
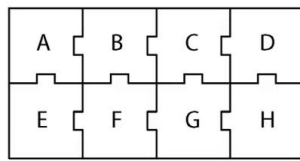


Here you see in a continuous flow, how with the knitting technique, boxes are successfully added from one row to the next.

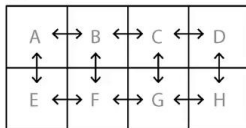
Notes

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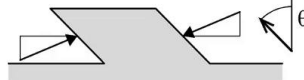
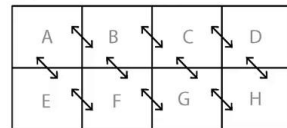




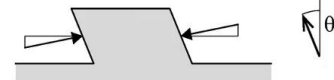
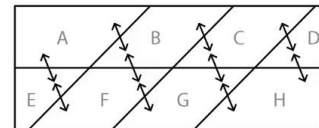
a.



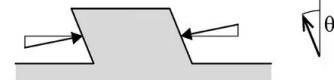
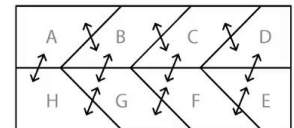
b.



c.



d.

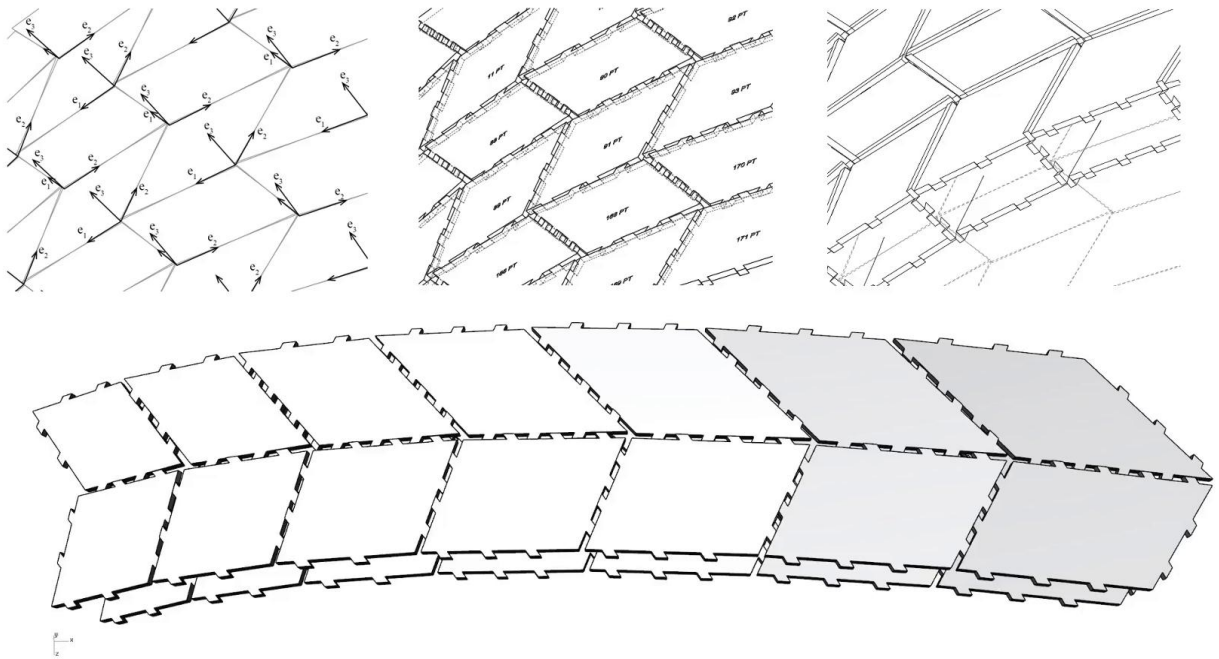


Insertion vectors have to be considered, as it shown here, for different assembly patterns.

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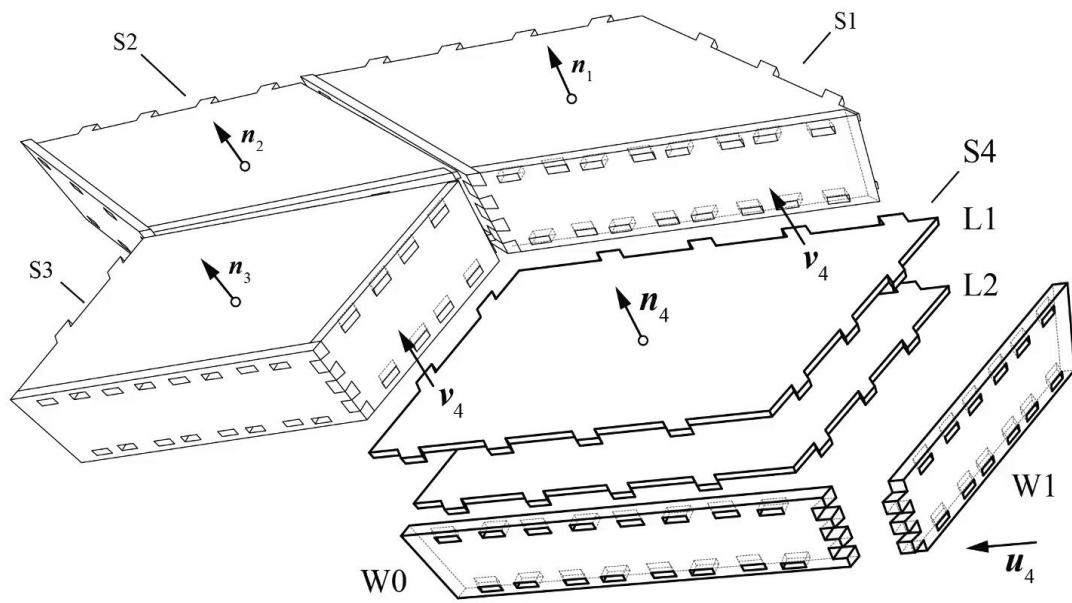


Boxes then can be assembled and form arches, and several rows up to seven are assembled for each arch.

Notes

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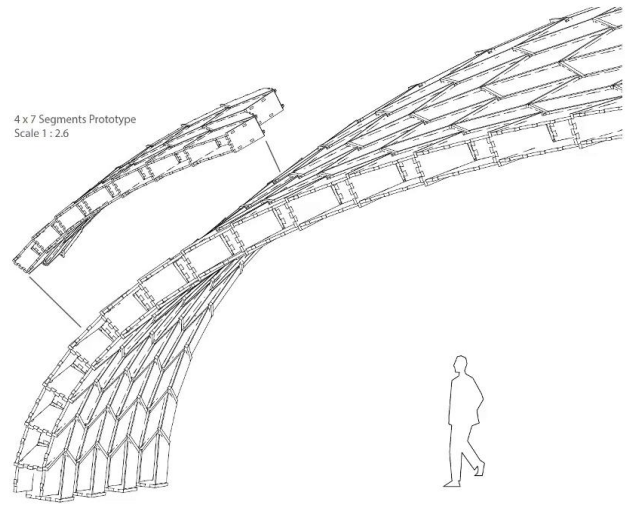
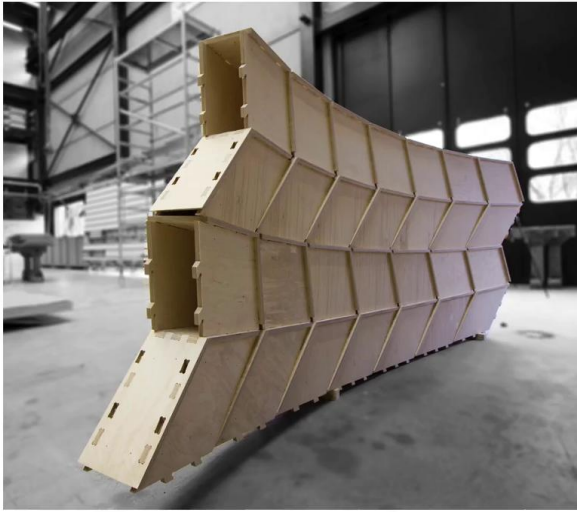
This slide shows several insertion vectors, which are common, for instance, to two different surfaces.

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Summary



■ Advanced Timber Plate Structural Design



This prototype, which was more a fabrication prototype, has been shown and explained beforehand.

Notes

Summary



■ Advanced Timber Plate Structural Design



It allowed us to verify the assembly sequence.

Notes

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2m 57s

■ Advanced Timber Plate Structural Design



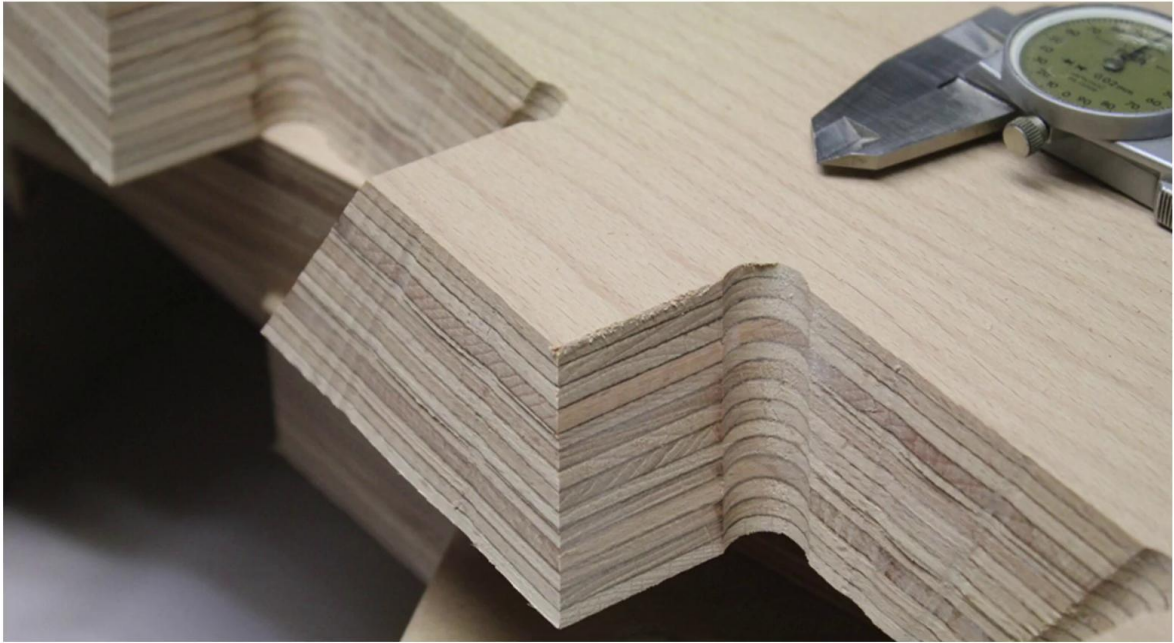
This prototype was also mounted at the [inaudible 00:03:06] campus.

Notes

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3m 02s

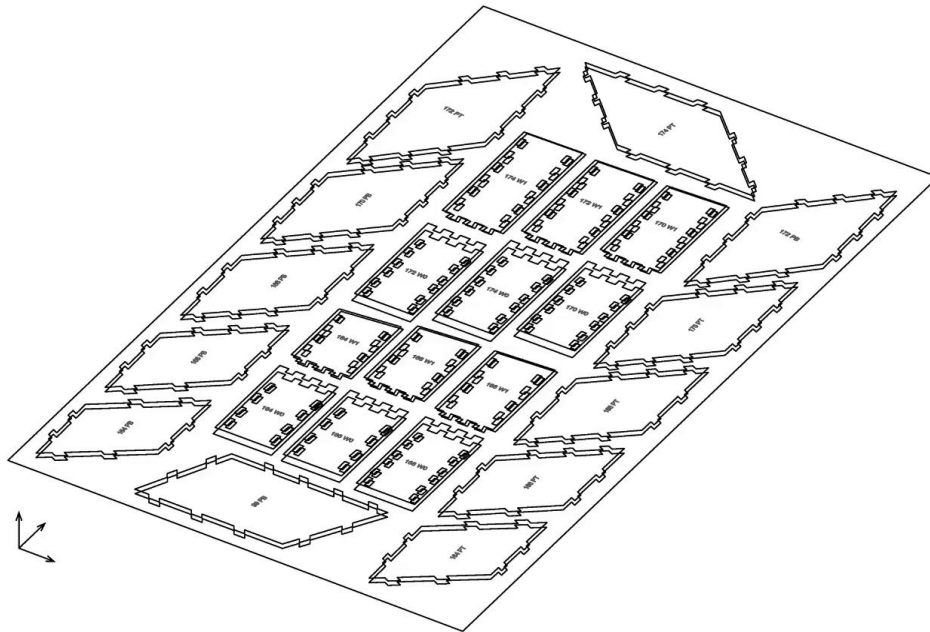


A half scale prototype was performed by the company and in Luxembourg with full plates, but health span. That prototype helped us to be sure about a montage of process at building scale. Thickness of panels, connections, every detail had to be controlled after fabrication.

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Summary





The whole panel set need to be laid out with a nesting process.

Notes

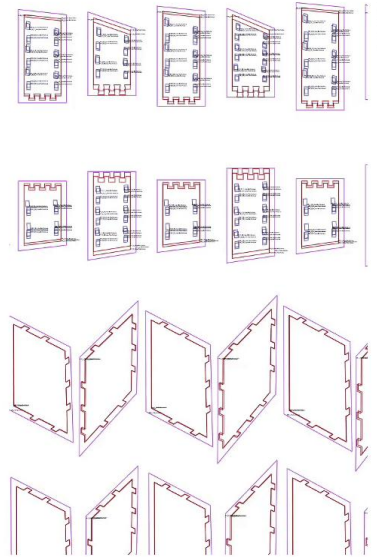
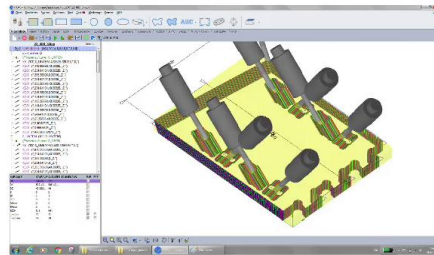
Summary



Biesse Rover High- performance Plate Machining Center



High-performance Plate Machining Center



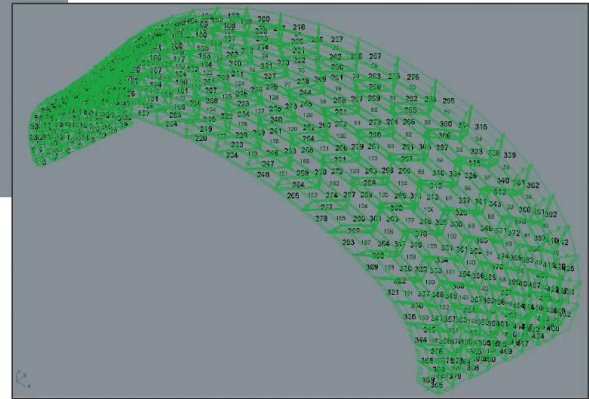
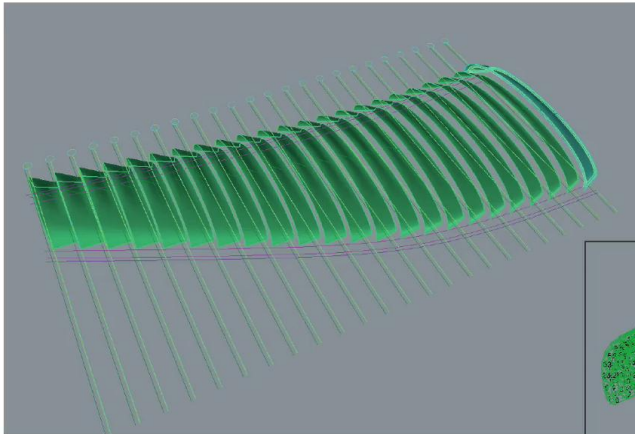
■ Advanced Timber Plate Structural Design

In this case, the company even invested in two CNC machines, which helped them to produce indoor the whole structure of their own building.

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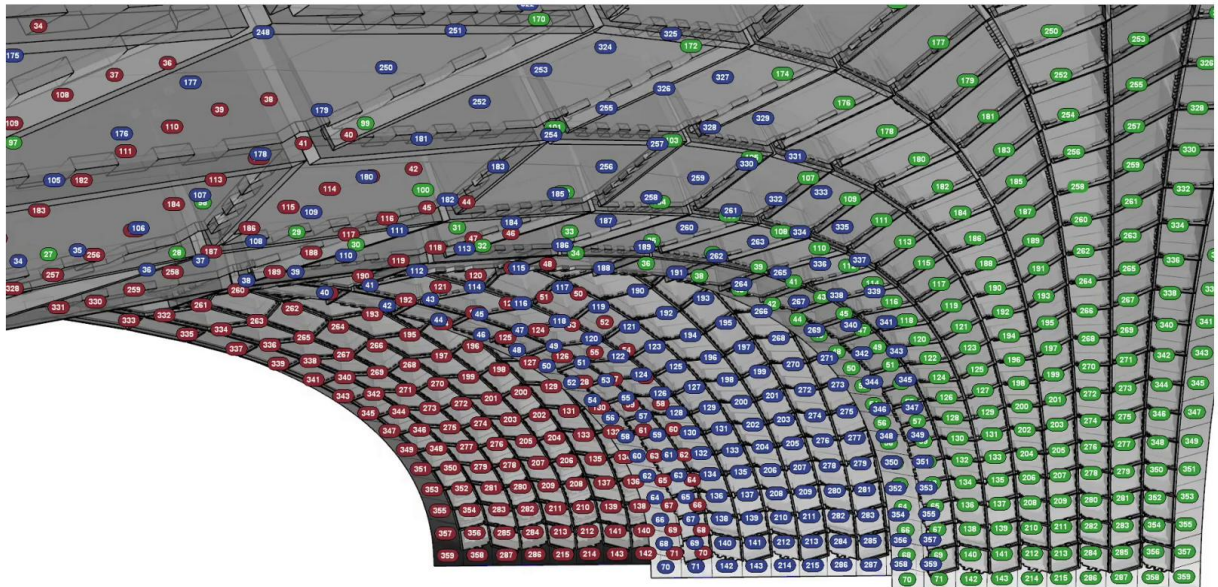
A parametric model describes fully all 23 arches, which are all different, and in each arch, all boxes, which are different, and all connections.

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Advanced Timber Plate Structural Design



In this slides, you see some views of that project and the way it's labeled throughout the process.

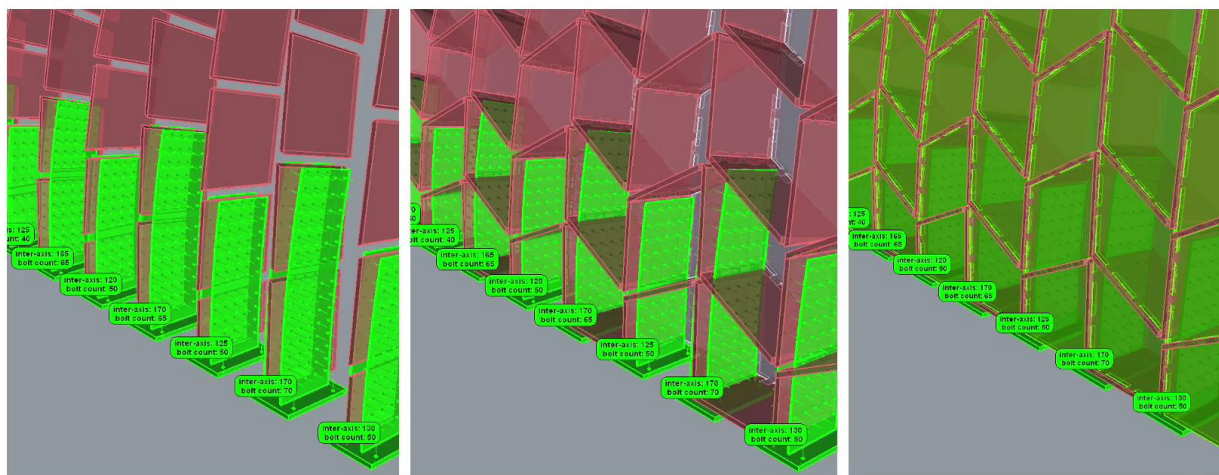
Notes

Summary

4m 06s



■ Advanced Timber Plate Structural Design



Additional construction details were needed to connect the archive with the concrete slab by introducing steel plates.

Notes

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4m 15s





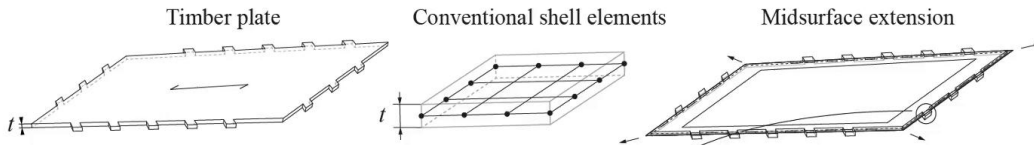
The full-scale prototype max two was erected in order to test also its structural behaviour at full scale. Here we see arch 22 and half of arch 21, which are connected and we should build first.

Notes

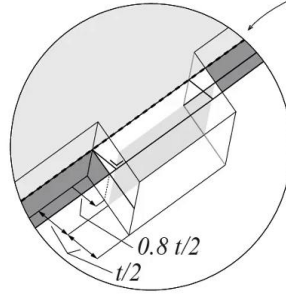
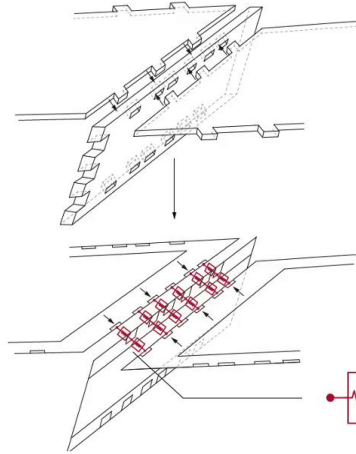
Summary



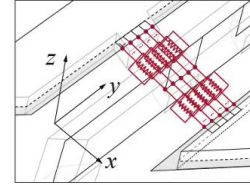
(a) Plate representation



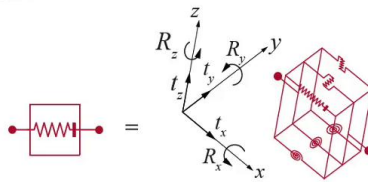
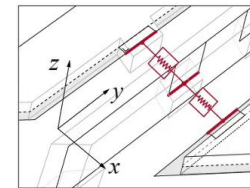
(b) Connection detail representation



(c) Discrete springs



(d) Edge-to-midpoint coupling



■ Advanced Timber Plate Structural Design

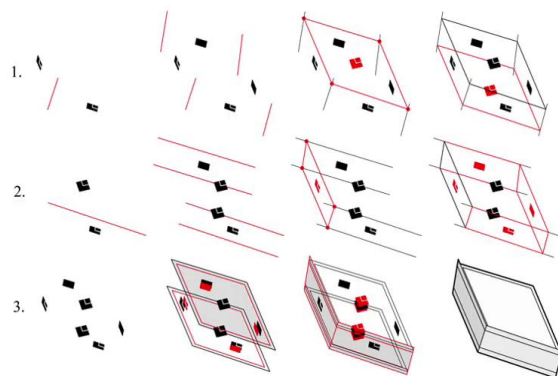
Additional mechanical investigations were performed on arches 821, and the rigidity of all wood-wood connections was improved on those arches.

Notes

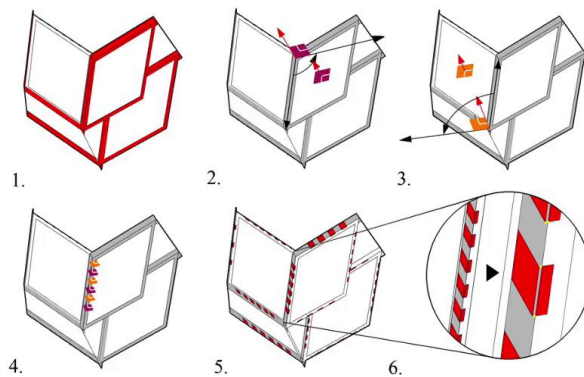
Summary



4m 42s



Génération des plaques



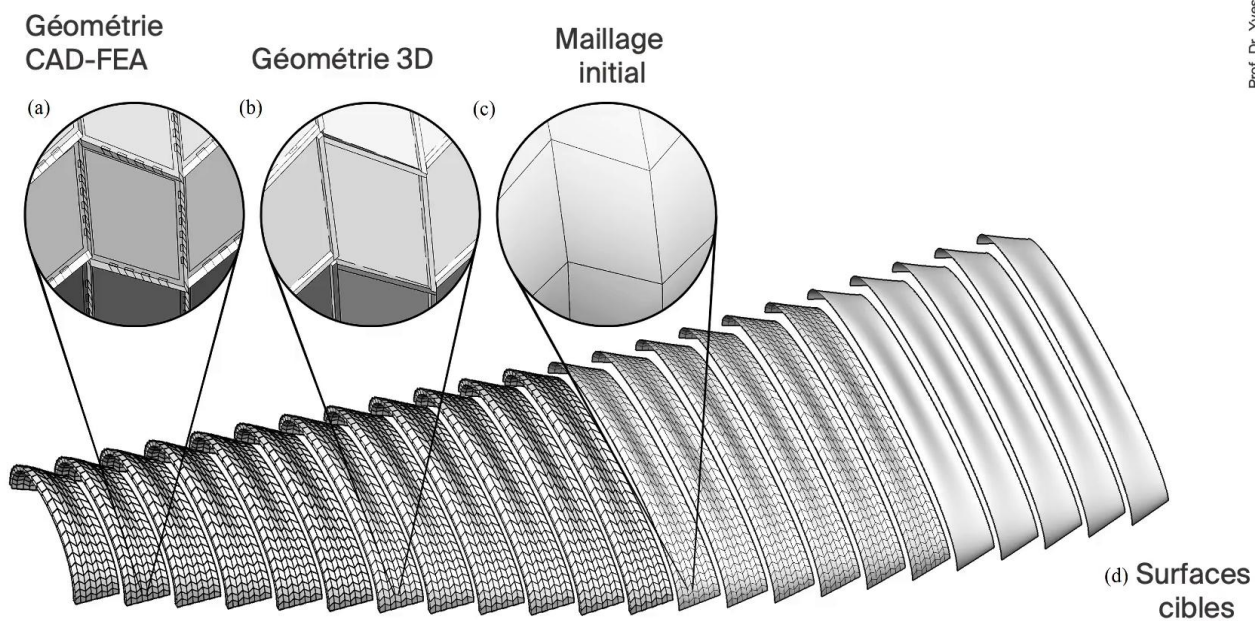
Génération des joints

In those slides, you see how the programmatic model allows to show all information for fabrication, but also to plot geometries, which then can use directly in the workflow for structural analysis modeling.

Notes

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■ Advanced Timber Plate Structural Design

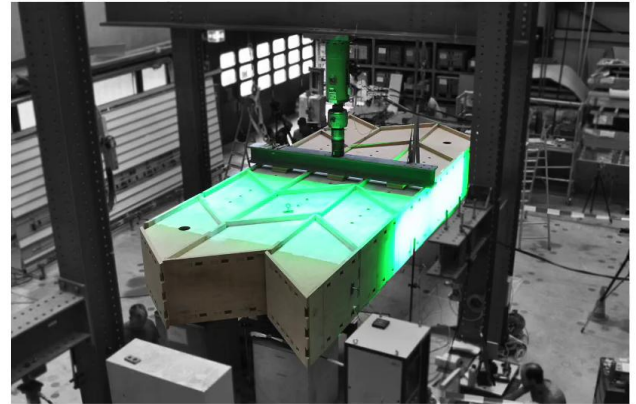
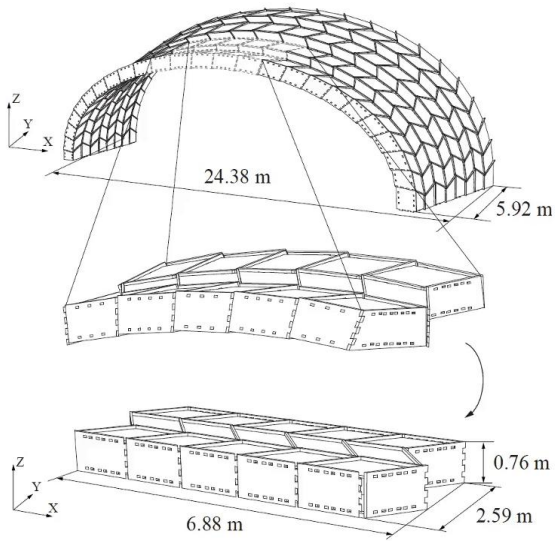
We believe that architects should also investigate in construction logistic, and specifically, montage logistics. They should now, in addition to the wide range of activities, not only show a form such, but also indicate how that form could be built, meaning how that form could be discretised and built.

Notes

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5m 13s



Three-point bending tests

Additional mechanical investigations have been done, as it has been shown in the past, also on another prototype, which has been extensively commented already, where we made mechanical validations of those connections.

Notes

Summary





This is an image of the first fullscale arch, which was built in Luxembourg. Those are the first images of the accomplished building, where you can see that the arches are visible as such in the final building, and that very light comes in between those arches in order to form a beautiful space. The envelope stays as an independent part, made out of 23 arches which are independent and which form that space. Here you can see one arch which is already built, rotated, put into a vocal position and then displaced with the help of two cranes in order to reach its final target position.

Notes

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5m 57s