# Innovations in Timber Engineering

# Hetzer`s Method

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**Abstract**:

The Hetzer method developed at the beginning of our century opened up a new era in timber construction.
Otto Hetzer ( 1846-1911) found out the use of glued laminated timber structures. The author reports on the development of Hetzer glulam and points out the examples of its application.
Especially the historical development between the years 1925 and 1945 was examined.
During and after World War I the shortage of steel and cement resulted in a rising demand of modern timber constructions. So in the 20ies in Germany various innovative timber construction methods were developed, which from this onwards competed with Hetzer`s structures.
The business activity of the beginning years was now over. However, in other states the production of Hetzer`s structures just began, like in Sweden and the United States. Only the development of plastic resin in the 30ies caused an intensive evolution of new building methods with the application of glued timber, which represents the transition form Hetzer`s glulam to glued timber constructions during the World War II when raw materials were scare, new structural dimensions and spans were invented.

## Conditions for Development of Timber Engineering at the Beginning of the 20th Century in Germany

The new artificial materials like steel and steel reinforced concrete have nearly replaced the timber on the field of bridges and halls between 1850 and 1900.
At the end of the 19th century the space to steel engineering, in which bold designed bridges and halls represented the growing efficiency of steel, became now distinctly.
Only in 1870 the German carpenters remembered of his own innovative ideas. The carpenters aspired an effective representation of their handicraft to exist in the competiton fight. Finally in 1903 they succeded in the foundation of the National Society of German Carpenters, which confessed in his statutes to an animation and promotion of the timber engineering.
At the turn of the centuries the number of carpentry firms increased again. The technique of timber engineering began to change: according to the steel development now evaluations of design methods and the theorie of strength were used. At the same time the test labors for materials dealed with the systematic research of timber.
The conservation of historic monuments concentrated on the maintenance of the numerous historic framework buildings in Germany. Also the railway directions recognized that the first platform roofs and engine halls in steel had to be pulled down due to the high corrosion as a result of the sulphureous damp.
Because of the minimal efforts in maintenance of timber constructions timber was again used during World War I in railway constructions and this lead into the fact that 90 per cent of all engine and car halls of the German Railway have timber roof constructions.
The European Railway directions supported the research in material and the engineering basis.
The regulations for timber structures, published by the German Railway in 1926, were the first timber engineering standard in Germany at all, which was continued and followed by the first DIN code 1052.
Ahead of this background it is accountable that the inventions of Otto Hetzer strongly influenced the development of timber engineering.

## Otto Hetzer - Pionier of Glued Timber Constructions

The Weimar Court Carpenter Otto Hetzer succeeded at the beginning of our century in lasting gluing of timber boards to whole structures.
Henceforth it was attainable to design constructions which are not dependent on the growing dimensions of wood and to manufacture them optionally bent and statically favourable. This fact inreased the efficiency of timber highly (fig.1).

Otto Karl Hetzer was born in Kleinobringen near Weimar on the 26th of February in 1846.
In 1872 Hetzer settled down with a sawing and

carpentry firm in Weimar.
Hetzer employed in 1880 about 80 laborer and enlarged his firm in the following years quickly.
The fast development resulted in a high indepteness and the factory was transformed into a joint-stock company. Otto Hetzer belonged to its leading shareholders. In 1910 he left the company and died one year later in Weimar.
The following development of his firm or the lives of his three sons can not be explored because of missed knowledge.

Otto Hetzer devoted his whole professional life to the improvement of timber application, which he connected with discovering new possibilities of applicating timber and the increasing of durability of timber constructions (fig.2).
One main point of his innovative ideas was the strength grading of timber and the arrangement of it in the cross-section due to the equivalent load.
He manufactured glued beams, in which he arranged the beech in the weight zone and the pinewood in the tension zone.
On the 22nd of June in 1906 Otto Hetzer obtained a patent for the invention, which represents the birth hour of the modern glued laminated timber building. The patent was the idea to produce a bent construction of several long sticks in an optional shape (fig. 3). The individual girders should be connected by an insoluble glue.
While manufacturing the construction the elements were pressed together. After the drying of the glue develops an inseparably connected area.

In 1907 the experts reported about the first building, where for the first time glued timber constructions were used and where also glued ceiling beams, an invention of the year 1890, with parabolic board arrangment were used.
Up to the year 1910 Otto Hetzer built about 65 roof constructions in glued timber with spans to 45 m (fig. 4). The cross section was always an I-cross-section (fig. 4 and 5).
Manufactured were in general structures without high shear stress and without tension perpendicular to the grain like 3-joint-bents or frame-works with spans between nine and 20 m.

Due to the recommendations of the railway directions to use timber constructions for platform roofs, engine and car halls, many railway buildings were built with timber.
The German Railway hall at the International World Exhibition 1910 in Brüssel had the considerable span of 43 m. The railstation buildings of Malmö and Stockholm, which were erected in 1923 and 1925, belong to the in the present existing monumentals (fig.7). Besides the building method was applicated in bridges, too.

According to the first buildings the economic advantages of the new method were especially emphazized , which really increased the level of timber according to the competition fight.
The method was in comparison to other techniques, f.e. the steel reinforced concrete, about 50 per cent cheeper (fig. 6).
Before the erecting of the first Hetzer buildings there were many experiments and tests on the strength and lasting of glued timber constructions. The official test labors for materials in Berlin and Dresden confirm that the durability of the glued cross-sections is also garantied after an open-air storage for month.
The strength of the glued beams was higher than the solidity of comparable non-glued timber beams.

During the manufacturing in the factory they payed attention of the careful way of producing : the planed timber boards were painted with glue and then the the cross sections were pressed together in the press. The hardening of the glue lasted about 24 hours. Due to the better bond of the glue air-seasoned pine-wood (Red fir) was used. But for open-air buildings it was recommended to applicate timber with a higher resin content because of its higher durability.

Already in 1913 a lot of firms in Austria, Swisse, Italy, Sweden, Norway and Germany had obtained the patent rights and put together to an representing federation with equal interests and the aim to promote the patent efficiently.
Especially in Swisse were built after a thorough examination about 200 constructions under licence during only 10 years (fig. 8).

Already in 1910 the National Society of German Carpenters founded a special Technical Committee for the promotion of timber construction methods, which assisted to the carpenters with technical drawings and statical calculations. Later the Technical Committee was changed into the Technical Buro. With the help of this buro now also carpenters could build Hetzer constructions, especially bent roof constrcutions with spans between 10 and 25 m (fig. 9).

After Hetzer`s death many other carpenters dealt with the searching for new innovative solutions for connecting techniques and construction principles, f.e. Tuchscherer, Kübler, Sommerfeld, Christoph and Unmak, Cabröl and Fritz Zollinger ( to Zollinger: see lit./4/).

The number of timber construction techniques with a patent fought a strong competition fight in 1920/25 in Germany. The relatively high costs for Hetzer constructions were now an obstacle for an application.
On the one hand there were really positive experiences according to the railway constructions, but on the other hand the experiences showed that the durability of Kasein glue did not always exist after a lasting exposure to moisture.

## From the Hetzer Method to the Glulam Timber Engineering

The first draft of the DIN code 1052 of the year 1933 included an special article about glued units, which formulated the general bases for manufacturing and application of Kasein glues for timber constructions.
The drafts of 1941 and 1944 contained an article to glues, which was more detailed and therefore valid unitl the 50ies. The regulation said that only special firms with an admission of the minister for work of Germany were allowed to design and manufacture glued timber constructions.

The development of artificial resin glues in the 30ies in Germany, originally for the plane industries, was the assumption for an further development of the Hetzer method, because now there was the possibility to create lasting glue-units, also unter wet conditions.
Besides it was now attainable to reach higher durability.
After 1935 began an intensive research on the field of gluing techniques in Germany.

The firms , which were well acquainted with the Hetzer method, f.e. Christoph and Unmak, Niesky or Karl Kübler, Stuttgart, took up this new idea and used now also rectangular cross sections, which frequently were used as flexural beams. In connection with plywood very economic constructions were developed.
Until 1945 in Germany a few Hetzer constructions were produced, but after 1938 more glued timber constructions were built. In comparison to other constructions techniques the iron elements could be saved and their demand on timber was rather lower than in Hetzer constructions (fig. 10-12).
Besides the development of gluing techniques Hetzer also dealt with the board joints. Hetzer avoided in highly stressed regions of the cross-section board joints consequently. But this requires long boards. So the firm Christoph and Unmak used after 1935 glued lap board joints.

In his experiments and their evaluation Egner developed at the end of the 30ies the finger joints of boards and found with the form C a favorable finger prolife, which made it possible connect timber sheet theoretically without an end ( fig. 13).
Although a few timber constructions were built according to the Hetzer method with I-cross-sections, more and more laminated timber with rectangular cross-sections were prefered.

In 1941 one of the greatest Hetzer construction was erected in the Netherlands: a 3-joint-hall as a salt depot with the span of 54 m (fig. 14).
In the United States the first laminated timber construction, a frame construction for a school with a span of 36 m, was built in 1936 (see /5/).
In Swisse the development before and after World War I decreased after 1925, but since the development of the plastic resin glues the Hetzer method now became again interesting for Swiss researchers and timber engineers.

In the new timber engineering boom during the World War II traditional bent Hetzer constructions were used as well as flexurally stressed structures. The fair hall VIII in Basel with 3-joint beams with a span of 45 m belongs to the important buildings of this time.

While in Swisse and the USA also shortly after World War II laminated timber constructions with spans to 65 m were erected especially for the army, in Germany only in the 60ies a new development in glued timber constructions began.
Until today the glued timber engineering was developed to a modern and competitive method due to an intensive research. Now assignments with spans above 100 m are technologically no more an unsolutable challenge, many examples show that (fig. 15). The production volumen of laminated timber is really considerable in the various industrious countries (fig. 16).
And even under ecological consideration it is to expect that the interest for this construction method will increase (fig. 3).

## Summary

Inspite of the fact that Otto Hetzer was not the first one who glued timber boards it is owing to him that he set a development moving, which revolutioned

the whole timber engineering in many states. The even in the present existing buildings, f.e. the railstation halls in Malmö and Stockholm, represent also after 80 years the courage to connect traditional handicraft with technical innovation. They also show that an expert manufacturing and maintenance of a construction garanties an using of long standing.

**Literature:**

Complete literature in /1/ and /2/


/1/ Rug, W.: Innovations in Timber Engineering - The Hetzer Method (part I) Bautechnik, Berlin 71(1994) 4, p.213-219

/2/ Rug, W.: Innovations in Timber Engineering - The Hetzer Method (part II) Bautechnik, Berlin 72(1995) 4, p.231-241

/3/ Rug, W.: Innovations in Timber Engineering - The Hetzer Method (part III) Bautechnik, Berlin 74(1997) 4, in preparation

/4/ Winter,K.; Rug,W.: Innovations in Timber Engineering - The Zollinger Method Bautechnik, Berlin 69(1992) 4, p. 190-197

/5/Rhude,A.J.: Structural Glued Laminated Timber- One Hundred Years in Making. Proceedings IWEC `96 New Orleans, 1996

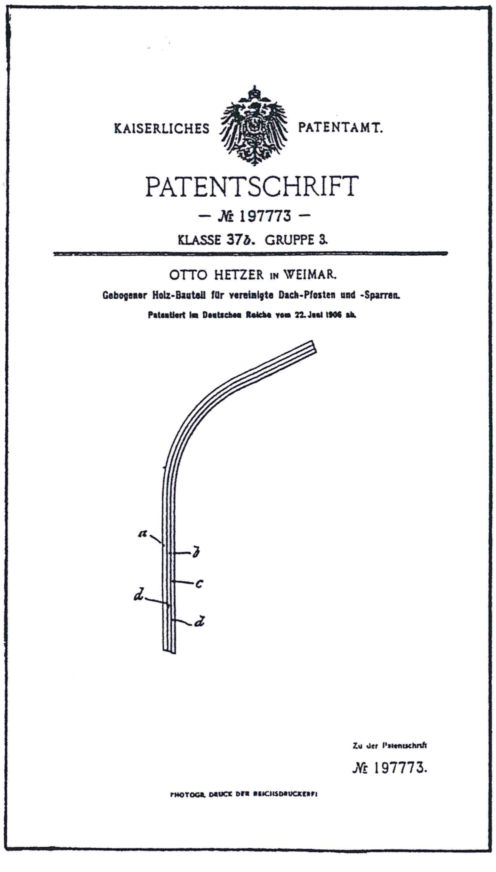




fig. 1. Patent for Hetzer`s construction

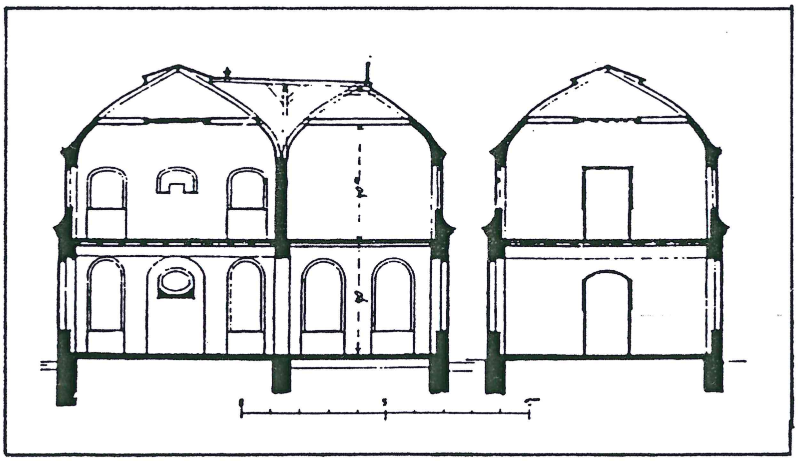


fig. 2. Museum of Altenburg

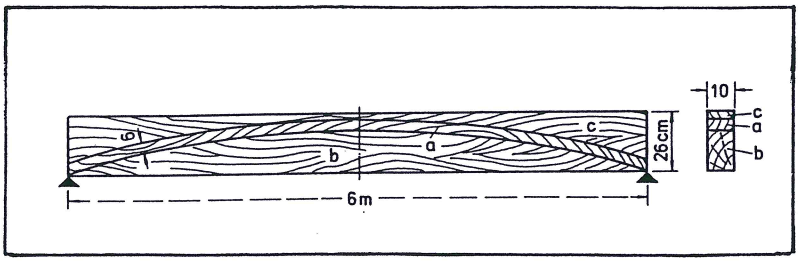



fig. 3. Glued laminated beam with a curved board

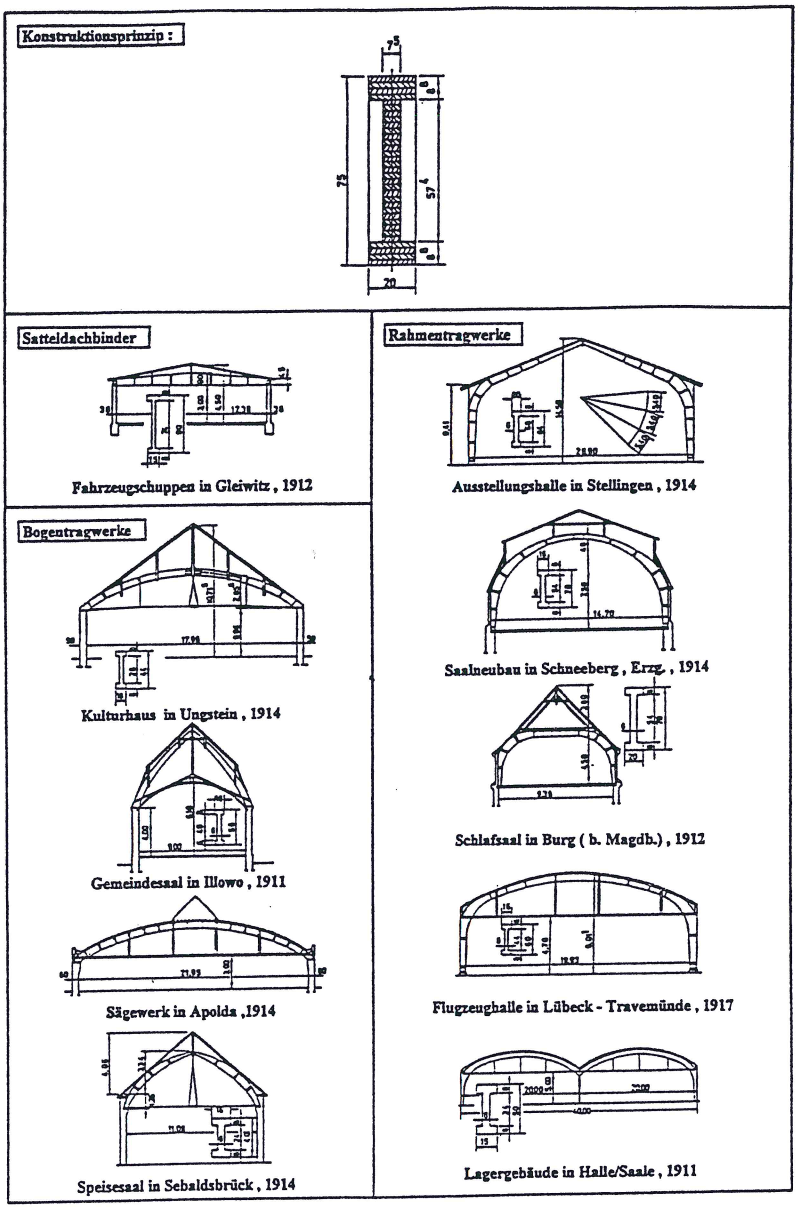
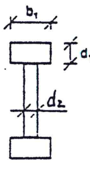



fig. 4. Roof and hall structures according to Hetzer

Tabelle: Gebräuchliche Brettstärken bei der Herstellung von Hetzerkonstruktionen




| | Dicke (mm) d1 | Dicke (mm) d2 | Breite (mm) b1 | Länge (m) |
|---|---|---|---|---|
| | 80 | 60 | 160 | |
| | 100 | 80 | 200 | 8...12 |
| | 120 | 100 | 300 | |

fig. 5. Usual dimensions of cross sections of Hetzer constructions

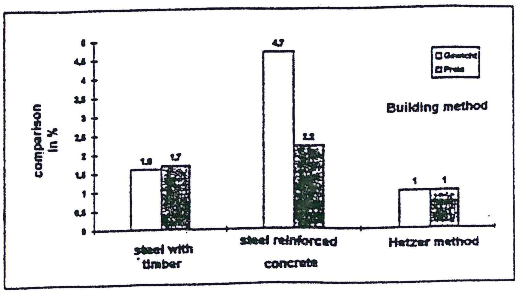



fig. 6. Comparison of different constructions at the Post Museum in Trier/ Germany

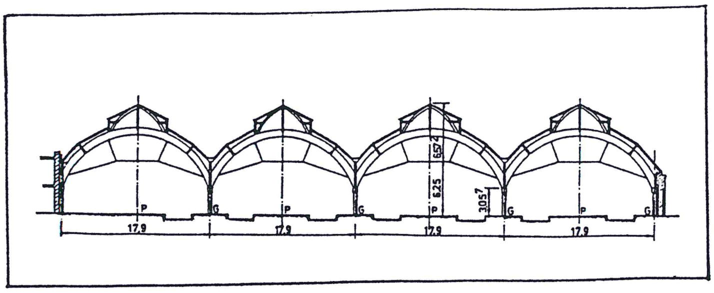



fig. 7. Railway station in Malmö (Sweden)

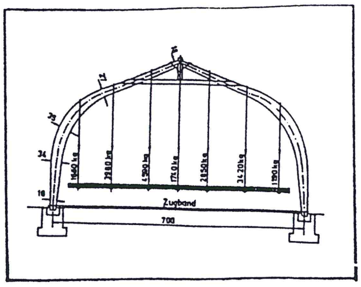



fig. 8. Equipment for failure tests (Switzerland, 1913)

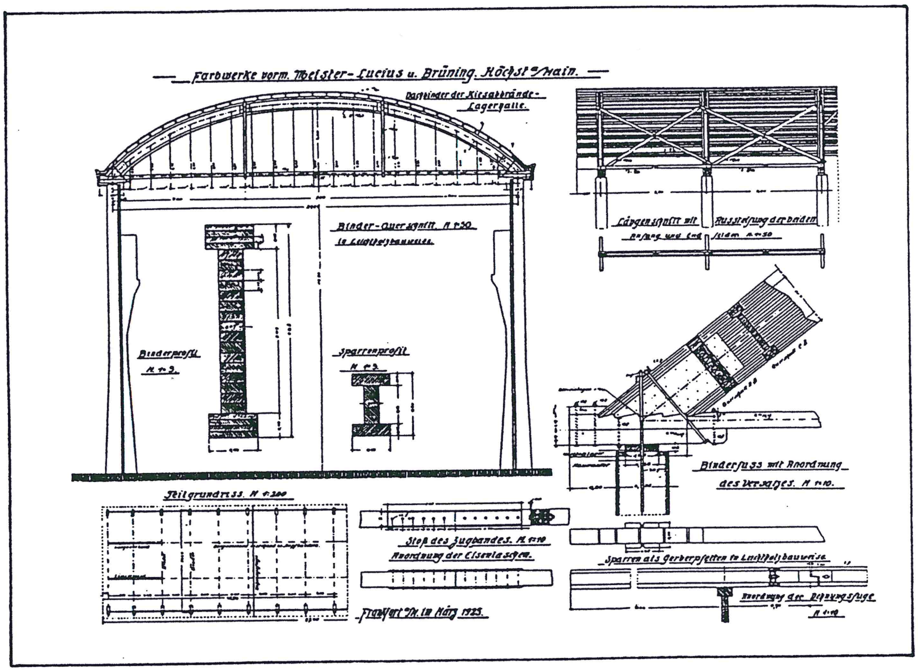


fig. 9. Industrial hall in Frankfurt/ Main, two hinged arch girders, span 21.2m
Design and calculation: Technical commission

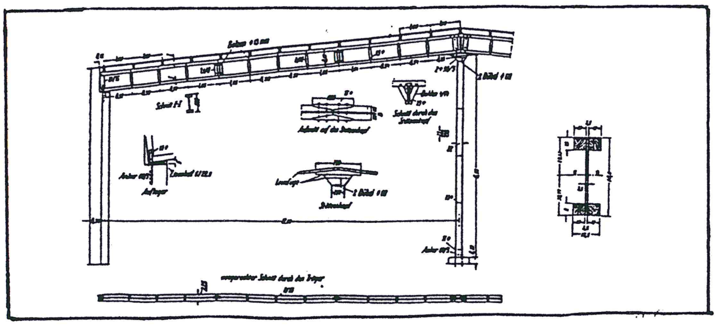


fig. 10. Rail car hall of the German Railway in Neuruppin, glued timber construction

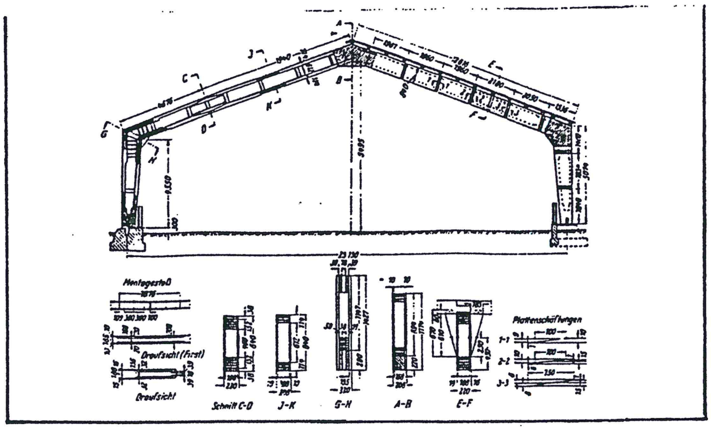


fig. 11. Riding hall designed by Christoph and Unmak Comp.

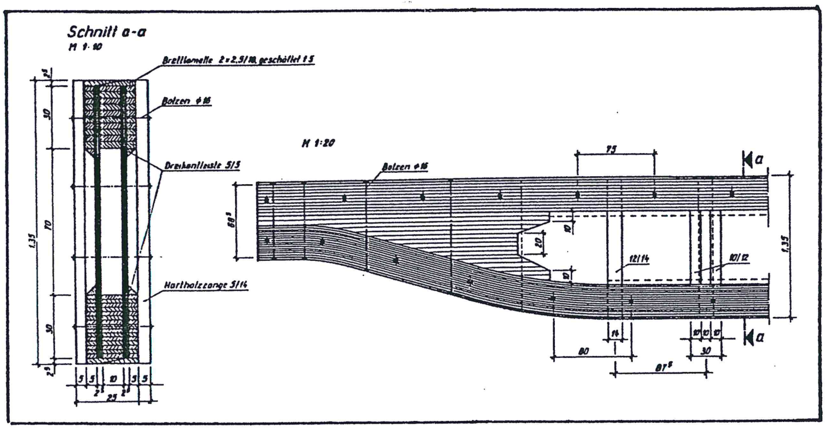



fig. 12. Crane girders of railway hall

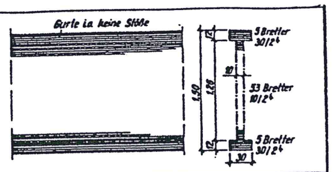
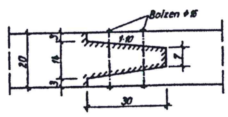
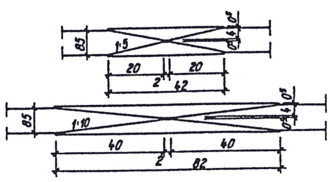
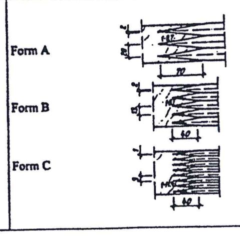
| | |
|---|---|
| Hetzer construction |  |
| Christoph and Unmak<br><br>board joint |  |
| Proposals for glued lap board joints<br><br>Graf and Egner |  |
| Suggestion of Egner for finger joints |  |

fig. 13. Development in

finger joints timber engineering

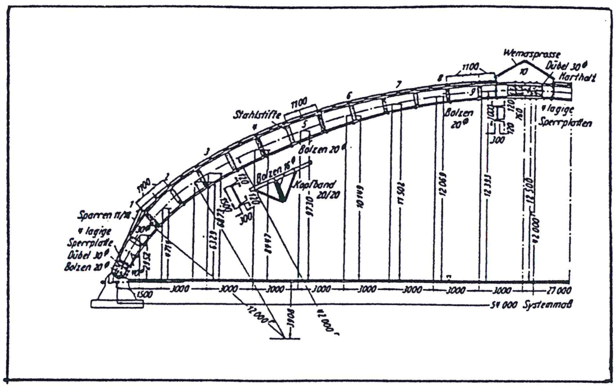


fig. 14. Salt depot in Doesburg/ NL,
in 1941 constructed by Christoph
and Unmak Comp., span 54 m

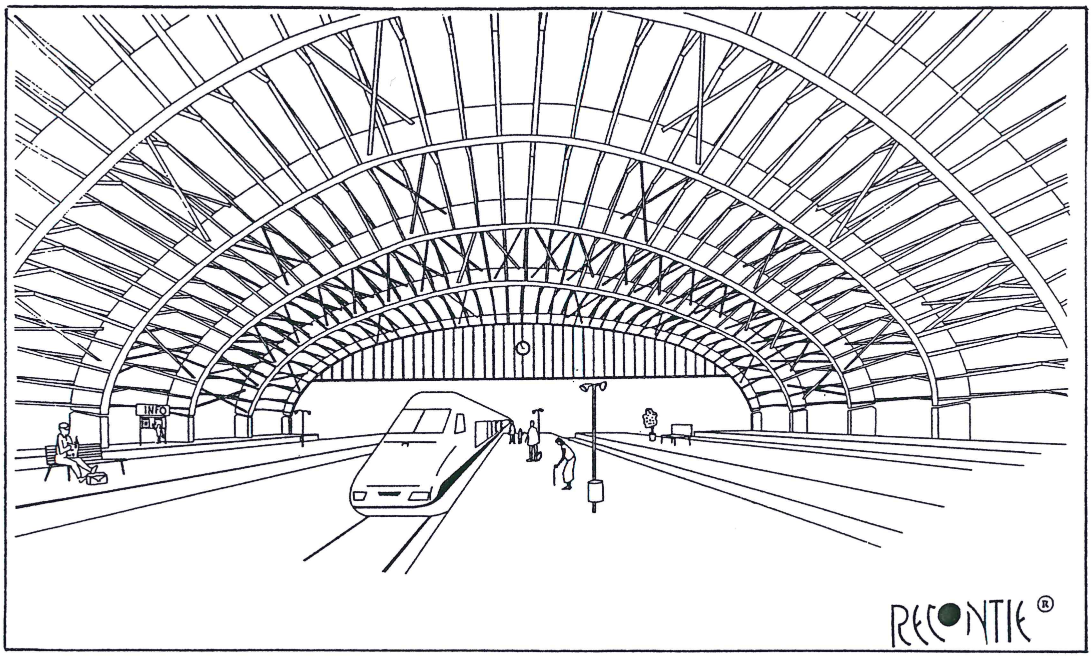


fig. 15. Railstation hall in glued laminated timber with a span of 70 m
( project study Recontie - Institute of Timber Engineering, Berlin )

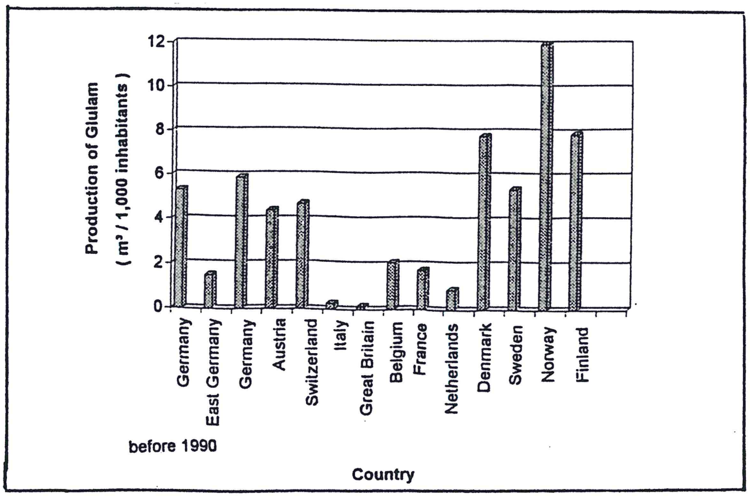



fig. 16. Production of glulam timber per 1,000 inhabitants in several industrious countries

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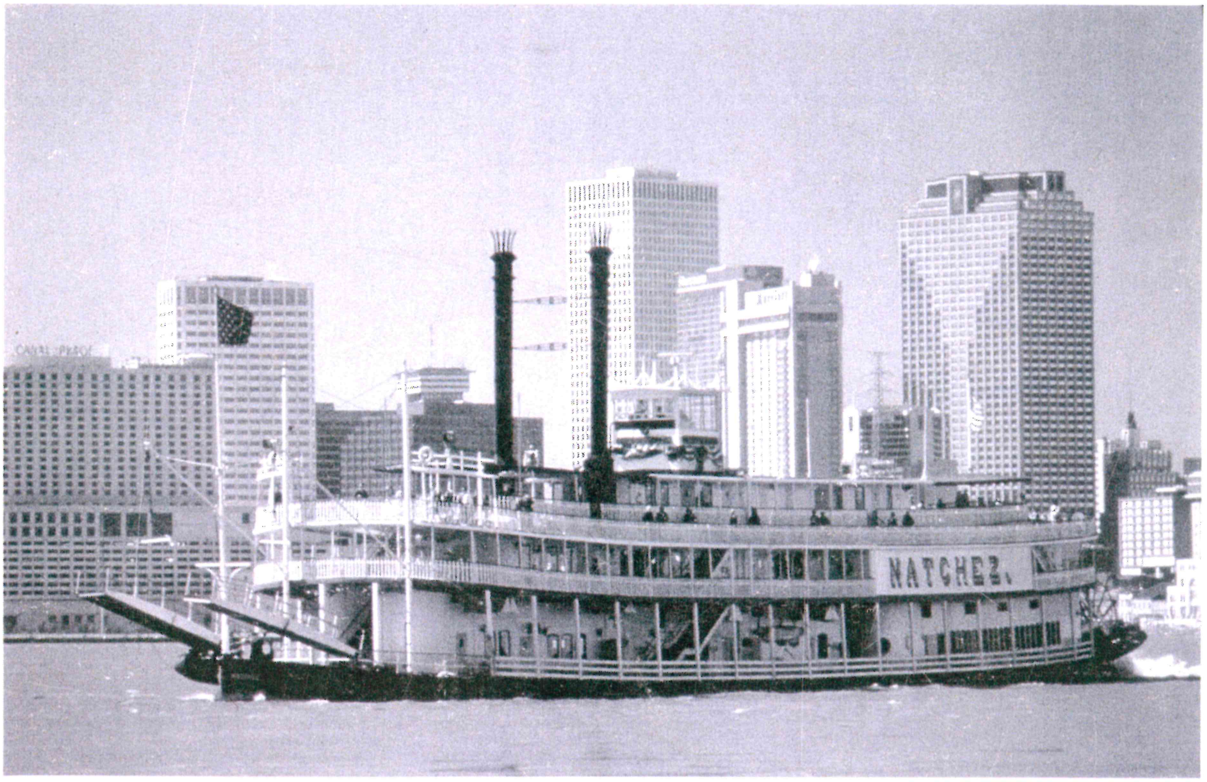


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