DILLINGER HÜTTE GTS

STEELS FOR CONSTRUCTIONAL STEELWORK : DI-MC

MILLAU VIADUCT

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A bridge-construction world record

For long years it has been a dream, now it has become reality: the great Millau Viaduct was opened to traffic on 16 December 2004, closing the last remaining gap in France's second north-to-south link, the A75 autoroute.

This elegant architectural masterpiece truly deserves its status as a record-holder. Not only is it the world's highest bridge, with a height of 343 m, crossing the Tarn River at an altitude of 270 m; its construction time of just thirty-eight months and its costs (around 400 million €) may well also be on course to enter the record books.
Planning for this stupendous project started in the late 1980s. As France's classical north-to-south route through the Rhône valley is always over-stretched in the summer months it was an obvious step to create an alternative connecting route – straight through the Massif Central, the precipitous hill region at the heart of France. But there was, above all, one natural obstacle: the broad valley of the River Tarn, close to the well-known village of Millau – well-known for its almost never-ending traffic jams every summer. Thus the decision was taken to bridge the valley with a 2,460 m long viaduct.

A multiple-cable-stayed bridge design

The decision to construct a multiple-cable-stayed bridge consisting of eight spans (outer spans 204 m each, and six inner spans, each 342 m), according to a design largely contributed by British star architect Sir Norman Foster, was taken in 1996.
he planning and implementation of the project were accomplished on a concession basis; the concession ends seventy-eight years from the start of construction, with the bridge's service life estimated at 120 years.

The target of shortening the construction period, and thus receiving income from tolls at as early as pos-

sible, was the reason for French construction group EIFFAGE and its subsidiary, Eiffel Construction Métallique, to draft a bridge consisting of a steel bridge deck and towers, being contrary to the original draft of a prestressed concrete bridge. This was, however, not the only convincing argument in favour of a steel solution (see box below), selection of which was confirmed in March 2001, with the start of construction work in the following October.

Within thirty months, Dillinger Hütte GTS supplied virtually 43,000 t of steel for the carriageway deck, the towers and the temporary piers used during construction.

Not only the company's broad range of dimensions and special steel grades favoured the selection of Dillinger Hütte GTS – it goes without saying that supply logistics must also be tailored in detail to such a project.

Modern steels permit cost-efficient production

Sophisticated selection of the steels to be used also made it possible to reduce production costs and shop processing times, via the use, for example, of plates with widths ranging up to above 4,200 mm and lengths up to 23 m.

This permitted an optimisation of the assembly of the deck from individual sections, with-out the need for additional welds. The use of blasted and primered plates also reduced fabrication time and costs. Almost half the structure consists of high-strength fine-grained DI-MC 460 structural steel.

The advantages of using steel

- **Lightweight, slender** bridge deck (36,000 t compared to 120,000 t for concrete)
- **Reduction of box girder height** to 4.20 m (lower wind exposure)
- **Safety:** Prefabrication, preassembly and the incremental launching technique reduced the need for work at great heights
- **Minimisation of the number of inclined tension cables** and foundation work
- **Durability** (120 years)
- **Reduction of overall project costs**

The special production process used, known as thermomechanical rolling, allowed the achievement of high strengths combined with excellent weldability. Thanks to this combination, it was possible, on the one hand, to dispense with time- and cost-intensive preheating in the fabrication shop, while on the other hand simultaneously reducing the weight of the deck structure, a significant factor in erection using the incremental launching method. DI-MC 460 was used primarily for the centre box sections of the deck (in thickness ranges of up to 80 mm) and for the towers. A plate thickness of even 120 mm was selected for the base elements of the towers.

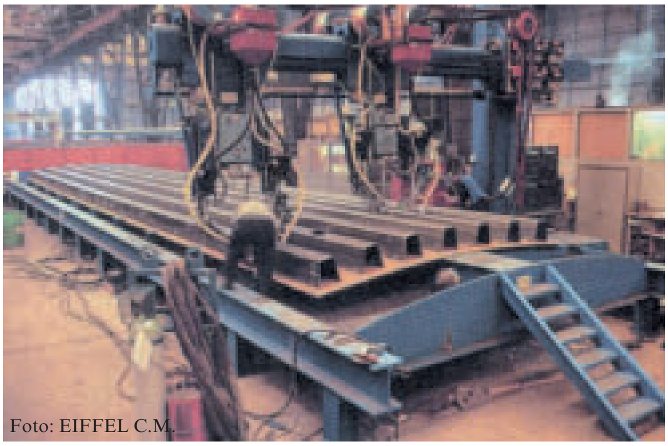
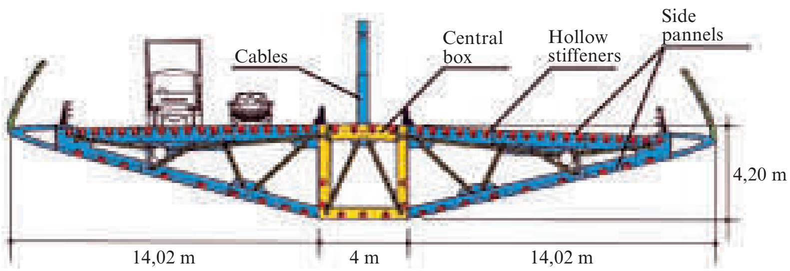


Foto: EIFFEL C.M.

Series fabrication and sophisticated erection

Eiffel Construction Métallique produced some 2,100 stiffened panels, a production rate of around four per working day, from plate and hollow sections at its workshops shops in Lauterbourg (Alsace). Following transportation to the site, these elements were welded together for a total length of more than 170 m at the two preassembly yards on each abutment. The central box sections had previously been preassembled at Fos-sur-Mer. As many as seventy-five welders were at times employed on each of these preassembly yards. Various strategies were deployed to master the enormous cantilever action encountered during the erection from the two abutments. Temporary telescopic piers were used, for example, to reduce the bridge's span during installation, a steel nose was also employed, and a tower completed with cabling was also inserted in each case. After joining the two deck elements from the north and the south on 28 May 2004 the remaining towers and cables were installed and the temporary piers removed after completion of the bridge.



Such outstanding engineering achievements truly deserve our admiration, and the viaduct is receiving this richly: More than 500,000 people have now taken guided tours of the site during the construction phase, and intensive "bridge-viewing tourism" is also anticipated for the future – it's a sight well worth seeing.

DH-GTS deliveries for the Millau Viaduct

Total:	appr. **43,000 t**	November 2001 to end of 2003 (1,600 to 3,000 t per month)
Steel deck:	appr. **36,000 t**	Towers: **4,600 t** Temporary piers (part): **2,400 t**
Among this:		
– **S 355 K2G3**	(≤ 30 mm):	**20,400 t** box girder panels and towers
– **S 355 N/NL**	(30 - 80 mm):	**3,800 t**
– **DI-MC 460**	(10 - 120 mm):	**18,000 t** center box section, various girder panels, towers and the tower feet in the deck
– **S 460 QL1**	(130 - 200 mm):	**172 t** for erection auxiliaries

Around 60% of plate material was supplied in blasted and primered condition.

All good things come in threes

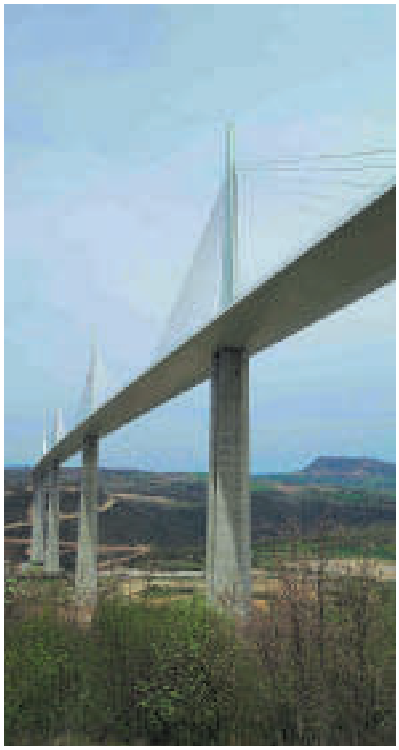
Although it is the Millau Viaduct which has captured the attention of the world, we should not forget that the completion of this alternative traffic route also necessitated the construction of two other exceptional bridges.

One is the Verrières Viaduct, a 720 m long composite bridge with a main span of 144 m at heights of up to 140 m, located 20 km to the north of Millau. This bridge's cross-section is made up of a rectangular 7 m wide and 4.5 m high box section stiffened with trapeze hollow stiffeners with projecting hollow sections and the resiliently braced concrete carriageway deck. Dillinger Hütte GTS supplied 4,900 t of heavy plate for this structure, including significant quantities of its high-strength DI-MC 460 fine-grained structural steel, especially for the highly-stressed towers. Thus, it was possible to reduce the construction's weight as well as to optimise the assembling by using the incremental launching technique.

Also worthy of mention is the Garrigue Viaduct with its steel content of 1,750 t. The cross-section is divided into two parts having each two 2.65 m high longitudinal girders in a 5.80 m distance. In distances of 7.4 m, the girders are stiffened with cross bonds made of HEA 600 profiles. The cross girders above the towers and abutments, however, are made of welded plate girders. The 340 m long bridge is divided into 5 fields with a length of 59 m, 3 x 74 m and 59 m.
For the first time DI-MC 460 T in thickness ranges of as much as 120 mm was used in the upper flange of the beams above the towers. In the lower flange DI-MC 460 T was used in thickness of 110 mm. About 290 t of this steel quality were supplied for this premiere.

Millau Viaduct: Facts and figures

Steel content of deck:	36,000 t
Total weight:	290,000 t
Length:	2,460 m
Total costs:	394 million €
Pier height:	up to 245 m
Total height:	343 m
Spans:	6 x 342 m
	2 x 204 m
Height of deck:	4.20 m
Width of deck:	32 m
Seven towers:	
Individual weight each:	650 t
Height:	88 m
22 cables per tower	
Duration of construction work: (2 million working hours)	38 months
Duration of concession: (including construction)	78 years



Partners involved

Concessionaire:	Compagnie Eiffage du Viaduc de Millau
Designer:	Michel Virlogeux
Architect:	Norman Foster
Preliminary draft:	SETRA
Stress analysis:	Greisch, EEG Simescol, Tháles E et C, Serf, STOA Eiffage, Arcadis
Construction consortium (consortium leader):	Eiffage TP
Concrete works:	Eiffage Construction
Structural steel (prime contractor):	Eiffel Construction Métallique
Heavy-plate deliveries:	Dillinger Hütte GTS

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