This is where world champions are made

The world's best meet in the new Stade de France stadium

Whoever travels in the evening by the shuttle bus, into the centre of the French metropolis, wipes their eyes in amazement. On the right hand side in the darkness of the Paris suburb of St Denis, what seems to be a giant saucer rises up into the air. Something even Jules Verne had not fantasised! Pointed antennae poke out of the metal surface illuminated in colour. When one approaches a little nearer, the traveller realises that the structure is a stadium, and the antennae are really eighteen towers, each sixty metres high. They support the giant, almost ellipsoid roof of the Stade de France to protect 80,000 to 100,000 spectators from rain, snow, sunshine and wind - some 25 metres before the entrances to the stadium.

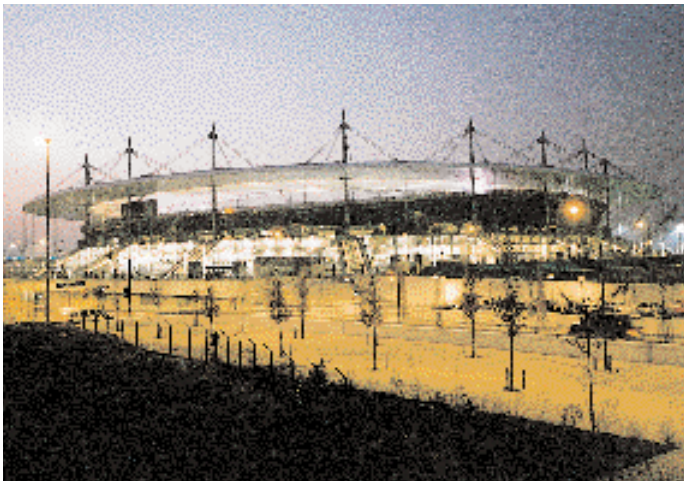


PHOTO: B. ANNEBICQUE-SYGMA

The arena lies seven metres below the former ground level. Jaques Brottier of 'CIE Construction' built a network of fixed points on concrete posts, measured with Leica total stations and Leica GPS systems.

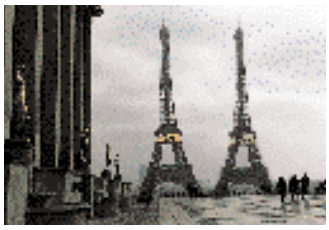
Football is the most popular game in the world. It was that round ball, which binds the people of the world (of whom more than two billion will be watching on TV when the final of the world championship is contested on the 12th July), that gave the impetus to the building of the Stade de France. The first match in the finals for the world championship takes place here in St Denis on the 10th June between Brazil and Scotland, followed by four further matches to decide the group winners, the quarter finals, the semi-finals and then the final.

Moveable stands

The Stade de France has also been designed for rugby matches, Olympic athletics and large scale concerts. Thus, following a football match or concert (such as the Rolling Stones concert set for the 25th July 1998) the lower section of the stand can be slid back by 15 metres, exposing the race track and sand pits for field and track athletics. In this way the spectators are always as near as possible to the events taking place.

Flying saucer

The nickname 'Flying Saucer', given to it by the neighbours, is accurate when the building is viewed from the ground. From a greater distance the overall effect of the construction, with its thin roof plate rising above the blocks of flats and fly-overs standing in front of it, is that it is floating gently. And with its pastel colours, it blends in with the high grey/blue skies over the Isle de France.

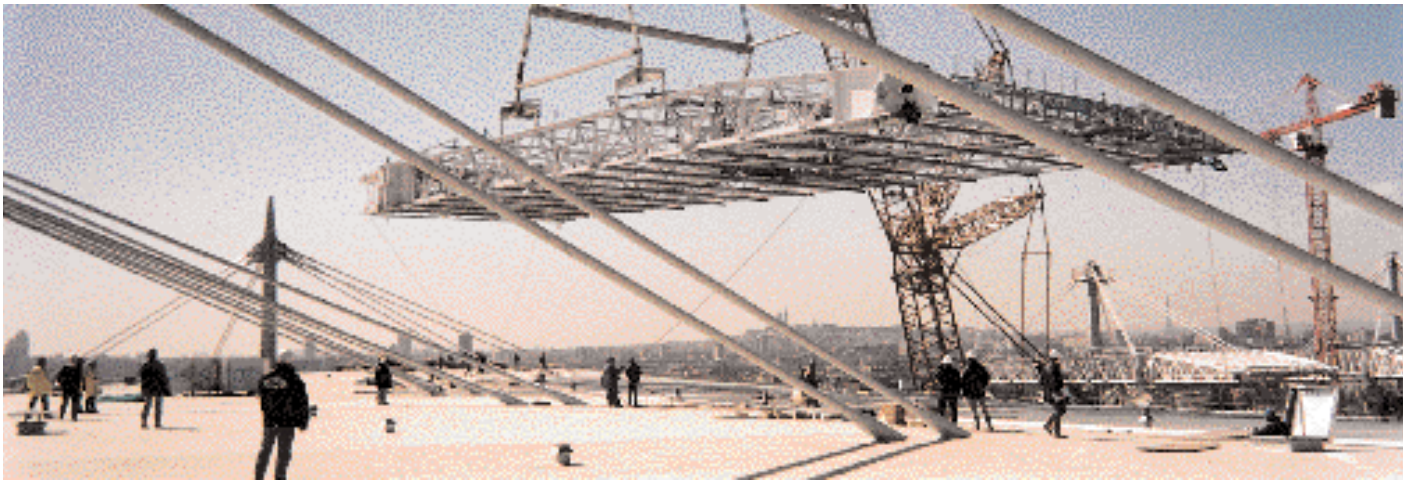


The roof of the Stade de France stadium alone weighs 14 000 tons - almost as much as two Eiffel Towers.

Below: The lower stand rows are movable. They uncover racetracks and sand pits for track and field athletic events. An audience of more than 100 000 can be accommodated for concerts.

PHOTO: D. QUENTIN/STUDIO TRONCA

PHOTO: CAILLEUX&FOUCHE



Above: The load-bearing elements for the 61 000 square metre roof surface were directed into position and surveyed by the firm Cailleux-Fouché.

However, the impression is quite different when viewed from the air. The massive 61 000 square metre roof surface is France's largest suspended roof. It has been designed to withstand a wind speed of up to 150 km per hour, and a layer of snow several metres thick. The roof alone weighs 14000 tonnes, which is nearly twice the weight of the Eiffel Tower.
This integration of aesthetic lightness and the enormous protective rôle has been successfully achieved by the GIE stadium project, and the architects Michel Macaray, Aymeric Zublena, Michel Regembal and Claude Costantini. The Stade de France was partly financed by the French State, but mainly by a private consortium of equal partners. Namely, Boygues, GIE Dumez-GTM-98 and Campenon Bernard-SGE. The same consortium is also in charge of its construction and operation.

Below: Surveyor C. Geneste of Cailleux-Fouché was on the construction site with two colleagues for 1½ years.

PHOTO: CAILLEUX&FOUCHE

Surveying at dizzy heights
According to Bruno Fouché, partner in the firm of surveyors Messrs Cailleux-Fouché S.A., no special problems arose in connection with the surveying. That is, of course, with the exception of the 'balancing act' on the steel girders at a height of 50 metres above the ground, the enormous dimensions of the objects and the speed with which the Stade de France had to be built. Moreover, for eighteen months from his firm alone, three surveyors were practically permanently present on the giant construction site.

Exemplary teamwork thanks to a common target
As Bruno Fouché said: 'Such a long time spent on a building site is unusual. This formed and strengthened the relationship with colleagues from the other areas of interest during the construction work. The teamwork with all partners was really first-rate and the whole organisation worked excellently.'
To tackle the set tasks, the surveying teams from Caillieux-Fouché principally employed the Leica TC1600 total station, the NA2000 digital level, and the DISTO hand-held laser meter. Using the latter instrument, the lengths of the 144, and up to 40 metre long support cables running from the

PHOTO: B. ANNEBICQUE-SYGMA

Below: Bruno Fouché used the Leica DISTO to determine the lengths of the anchoring cables. A Leica TC1600 tacheometer was used to determine that the towers and the roof structures were vertical.

PHOTO: CAILLEUX&FOUCHE

The highest points of the 18 towers are Leica reflector prisms for automatic control measurements. At the very top C. Geneste took a photograph of himself, there being no more room for a photographer!

PHOTO: PHILIPPE GUIGNARD

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Top: Here in the Stade de France in St. Denis near Paris the final match of the World Cup championship takes place on 12th July 1998.

Left: The large construction site in June 1996.

pinnacles of the towers down to their anchorages was ascertained. This was achieved after completion of the roof, to the millimetre exactly.

The stadium foundation also rests on Leica measurements

Leica instruments not only dominated the lofty heights during the construction of the 'Flying Saucer'. They were involved a long time beforehand in the St Denis valley, during the surveying activities for the original measurements and the various preliminary works carried out for CIE Stade Construction.

Jacques Brottier, Director of the topographical service said: 'After the work of laying out, I arranged for the measuring of the arena. It was to be created on the land seven metres below ground level, and in close proximity the erection of concrete piers with fixed point markers. The arena was to be measured as precisely as possible by traditional methods with a Leica TC1700 total station.

For a comparison we also checked the network with Leica GPS Systems 200. We found an excellent uniformity with a maximum of three millimetre deviation between two points'. This work was checked and confirmed by independent surveyors (the firm of Messrs Daniel Legrand).

Verification measurements by independent experts

For the test measurements of the eight main point X/Y co-ordinates aligned on the Lambert system, as well as for measuring a progression on the ground for determining inclinations, angles and distances, the firm of surveying expert Daniel Legrand employed not only the Leica GPS Systems 200 but also the Wild T2000 theodolite with a Wild DI2000 distance meter. To determine the exact height of these eight fixed points to the hundredth part of a millimetre, the Wild NA2 automatic universal level with a GPM3 parallel plate micrometer was brought in.

PHOTO: B. ANNEBICQUE-SYGMA

Below: Inauguration match France v. Spain in the Stade de France following the official opening at the end of January 1998.

PHOTO: D. QUENTIN/STUDIO TRONCA

More than 30 000 points marked

Finally, during the construction work the fixed points were packed and transferred into the concrete of the floor area. As Jacques Brottier said: 'The main difficulty here was to retain the fixed points, or to replace them at any time without losing their accuracy whilst the hectic building work was in progress. It was just at this stage that our teams were mainly occupied with the construction, and that meant measuring, measuring and measuring again.'

Left: A position for boarding is determined exactly with a Leica theodolite mounted with a DI1000.

With five two-man teams the topographical service alone placed about 30 000 marking poles, sticks and bolts, not counting the markings made with a pin and a tube of paint.

Speed and precision

We wish the football teams from the 32 nations who have qualified for the World Cup Championship Finals 1998 this degree of precision as well. In sport too, as in the field of surveying, the quickest, most precise and best disciplined team will win. More than two billion spectators and viewers will follow the players. However, it was the surveyors who helped the builders create this splendid arena.

Fritz Staudacher