

TERRELL

PRESENTATION OF COMPLEX STEEL STRUCTURES

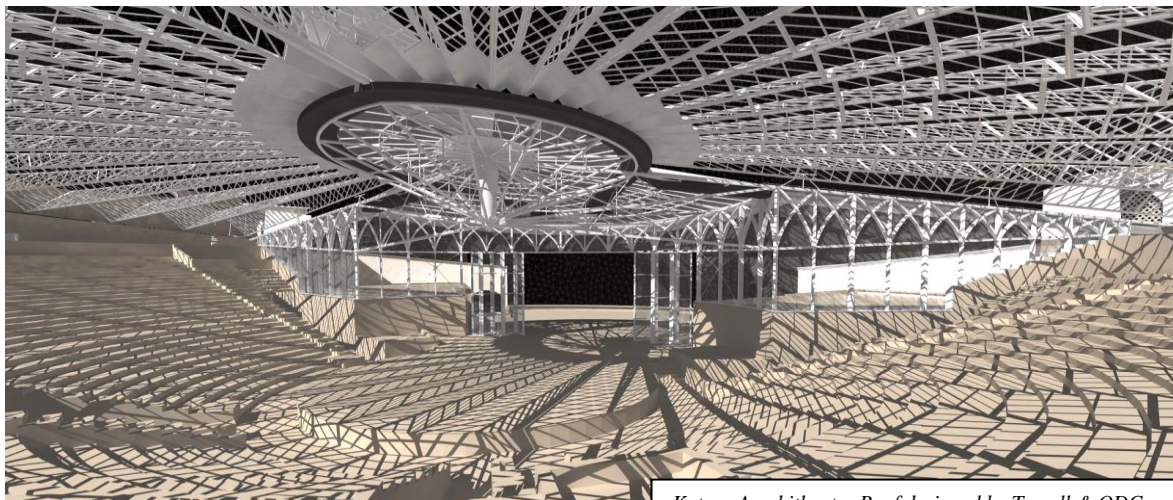
2-4 October 2014, Tripoli, Greece

The **Terrell** Group is a leading consulting engineering firm with its headquarters in France and offices in the U.K., the Arabian Gulf, Russia, Morocco, and Australia. **Terrell** is renowned for its expertise in structural, building services and façade/envelope engineering.

Created in 1982, **Terrell** has contributed extensively to the development of composite steel and concrete building structures. Our references in concrete, steel and timber construction are numerous and emblematic including: high rise towers, large scale public facilities (including schools, hospitals and housing), office buildings, sporting and cultural facilities.

Terrell collaborates with leading architects on the technical design of projects with engineers that bring innovative solutions to all fields of engineering activities with multi-disciplinary expertise and experience on complex and varied projects.

Terrell has a truly international culture. Numerous projects in Europe, the Middle East and further afield have put us in a leading position in terms of technological innovation and project insight not only in the structural field but also in those of MEP and facades/envelope.



Katara Amphitheatre Roof designed by Terrell & QDC

Terrell's approach to structural design increasingly incorporates 3D global modeling and thereby the concepts of BIM (Building Information Management).

Modeling in 3D for the calculation of complex structures has been part of **Terrell's** design approach for over two decades and the transfer of this approach to the graphic representation and modelling of structures in 3D has accelerated considerably in the last ten years.

We pride ourselves on the innovation we implement in the construction market and on the benefits cutting-edge Building Information Modeling brings to our clients. This approach enhances project collaboration, improves design accuracy and enables a faster design process, as well as ensuring compatibility between all disciplines.

All the projects shown below are exceptional in their design, their geometry or their architectural impact. These aspects initially appear highly complex but can be rendered simple with a geometric rationalization in 3D.

The Luma Foundation project in Arles for example, introduces a complex architectural image but its structural approach proved to be simple after geometric/clash analysis. Working in close collaboration with Frank Gehry's architectural teams and all project participants, TERRELL was able to implement this simplified structure with all the teams whilst respecting the architectural envelope.

Similarly, close collaboration with Mohamed Harasani Architects (M.H.A) on the extension of the Chamber of Trade and Industry in Jeddah allowed a radical change of the load-bearing structure and the facade. Indeed, **Terrell** proposed that the loads of the towers be concentrated on 4 columns, thus allowing the floor levels to be completely freed up, providing a very original concept.

1 Parc des Ateliers, Arles, France



Parc des Ateliers, Arles designed by Frank Gehry Architects for the Luma Foundation

This LUMA Foundation Project is a future cultural park, located in the 'Parc des Ateliers' in Arles (South of France), a site formerly used by the railway industry.

The project consists of the construction of a principal new building, refurbishment of various existing buildings as well as architectural landscaping of the entire zone.

The project focus is the new museum/exhibition building; a 10 storey tower, supported on a 2 to 3 storey plinth.

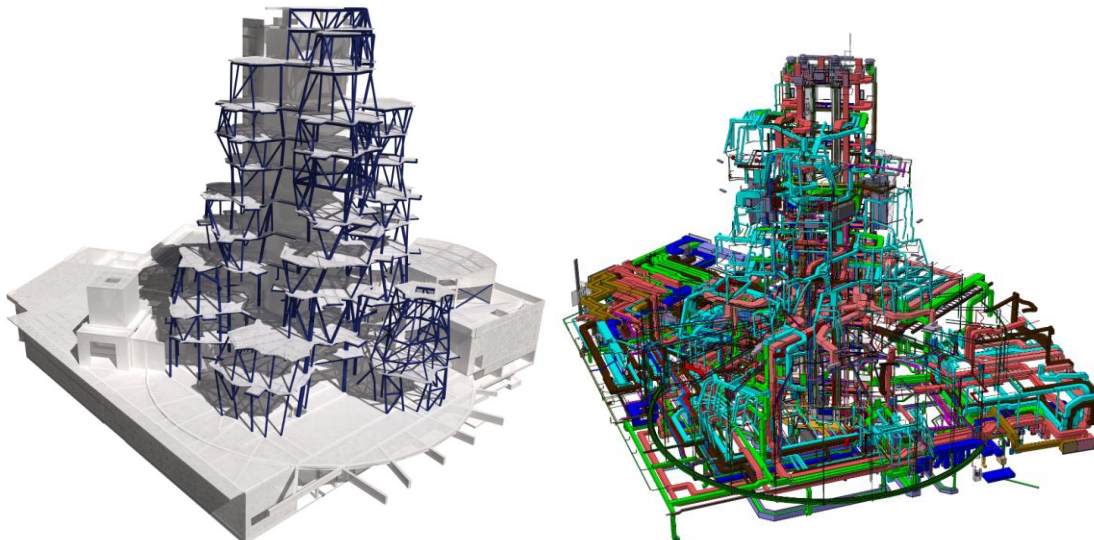
- Three sub-towers are joined at each level by a central slab. An eccentrically placed core provides the stability. Each of these sub-towers is covered by a striking façade of large metal 'blocks' (1m x 0.5m roughly), superposed to create an irregular geometry in elevation and in plan.

- The structural solution consists of a network of inclined tubular steel columns, carefully placed to allow the transfer of loads to foundations, whilst following the form of the façade.

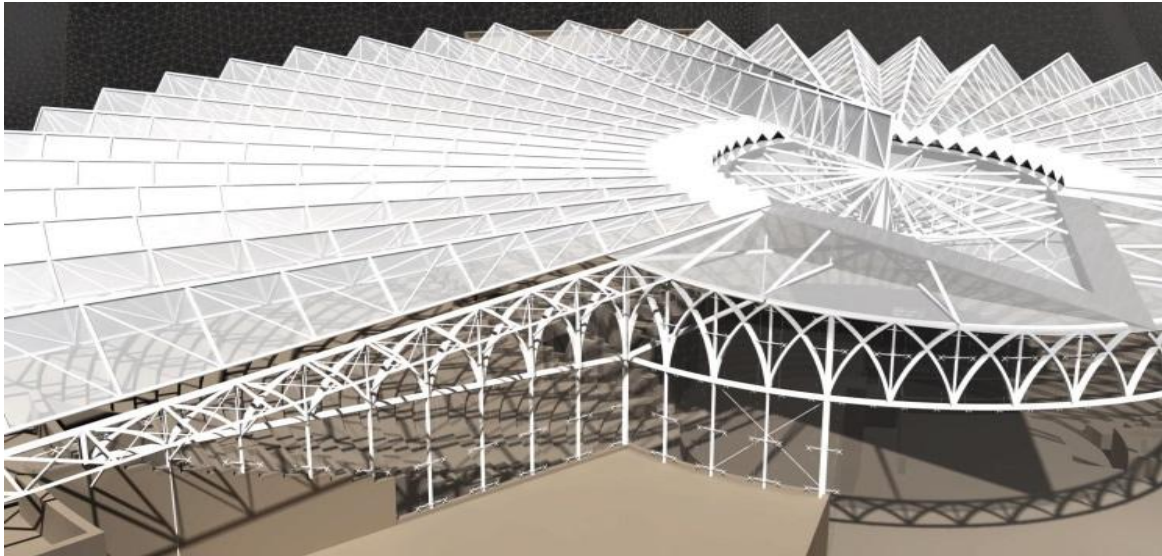
- The Tower and Plinth design also considers the important interface with the glazed Drum façade.

- The project is based on a central plant which features energy efficient upgraded heat-pumps. One part of the electricity production is achieved via a rapeseed oil CHP unit, which also takes part in the heating/cooling production via intermediate of a heat exchanger and an absorption chiller. Room climate control is achieved via reversible radiant floors and double floor ventilation with optimised heat recovery between extracted and outside air. BMS operated natural ventilation is also part of the design and source of electricity saving.

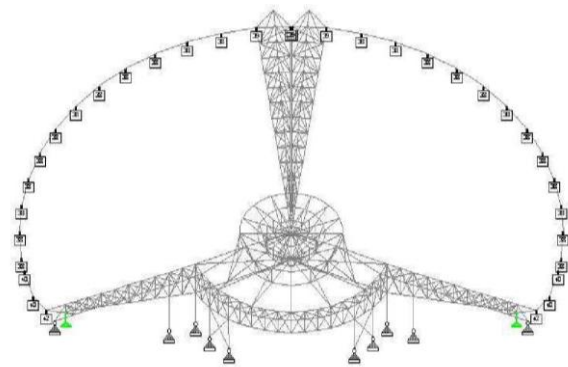
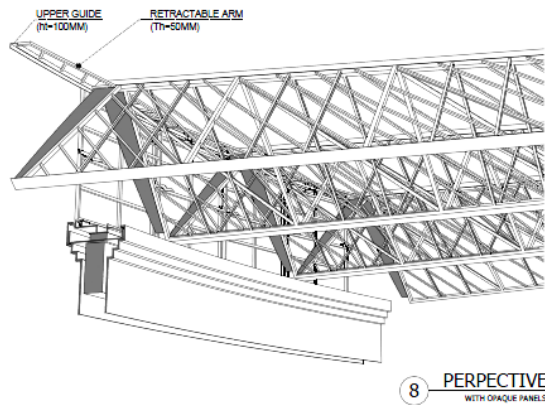
- The project relies on multi-disciplinary 3D modelling.



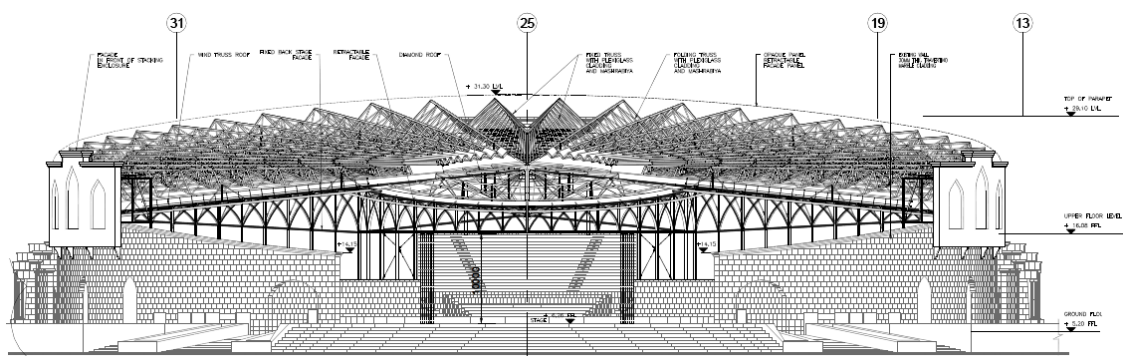
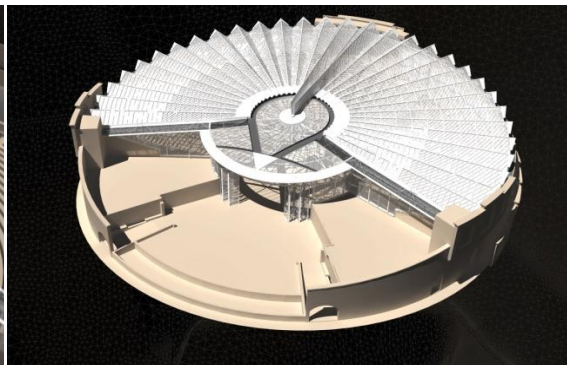
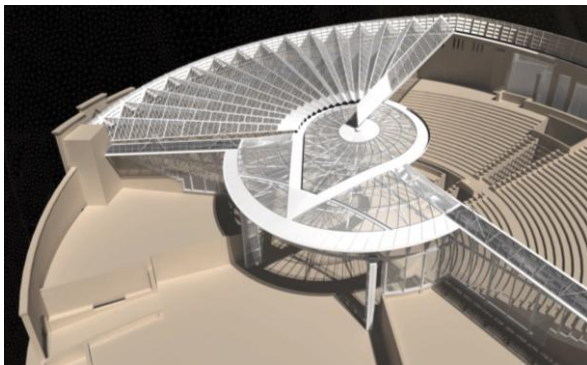
2 Katara Amphitheatre Retractable Roof – Doha, Qatar



The project is for the creation of a roof covering for the existing Katara Amphitheatre. Terrell designed a fan-shaped light-weight metal roof structure with a moving plexiglass covering suspended from a central glass core. It also allows for an air-conditioning facility to be installed for use throughout the year.



Model used for closed roof configuration (all inactive members are hidden)



3 Jeddah Chamber of Commerce & Industry, Jeddah, Saudi Arabia

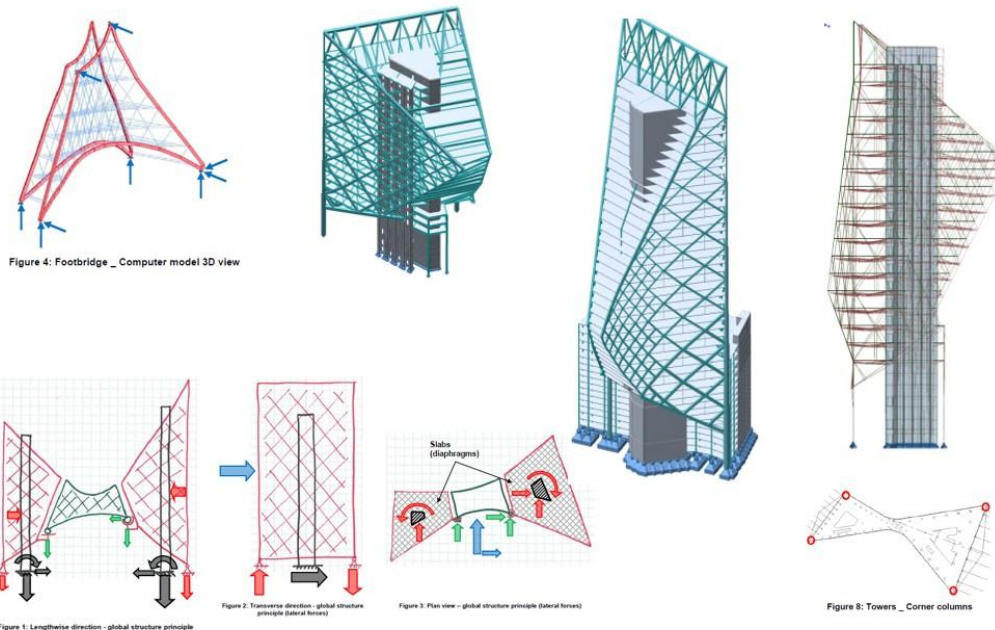


JCCI Extension designed by Mohamed Harasani Architects

The extension of the Jeddah Chamber of Commerce & Industry consists of the construction of 2 new towers (one of 190m and one of 90m high) of about 130 000m² built up area including 4 basement levels of car parks and service utilities. The towers are used for offices and a hotel. They are linked together via a 5 storey section spanning 60m over the existing JCCI building. Floor slabs are supported by a diamond shaped steel structure on 4 main columns located at the corners of the building. Lateral stability is assured by the towers' concrete cores. The bridge section is supported by the steel diagrid with expansion joints at each support.

The substructure is composed of 4 basement levels. A diaphragm wall with 3-4 rows of anchors provides stability to the shoring and resists earth and water pressures. A raft foundation sitting on deep piles transfers loads to the soil.

The complex geometry of the structure required a 3D approach to design using BIM techniques.

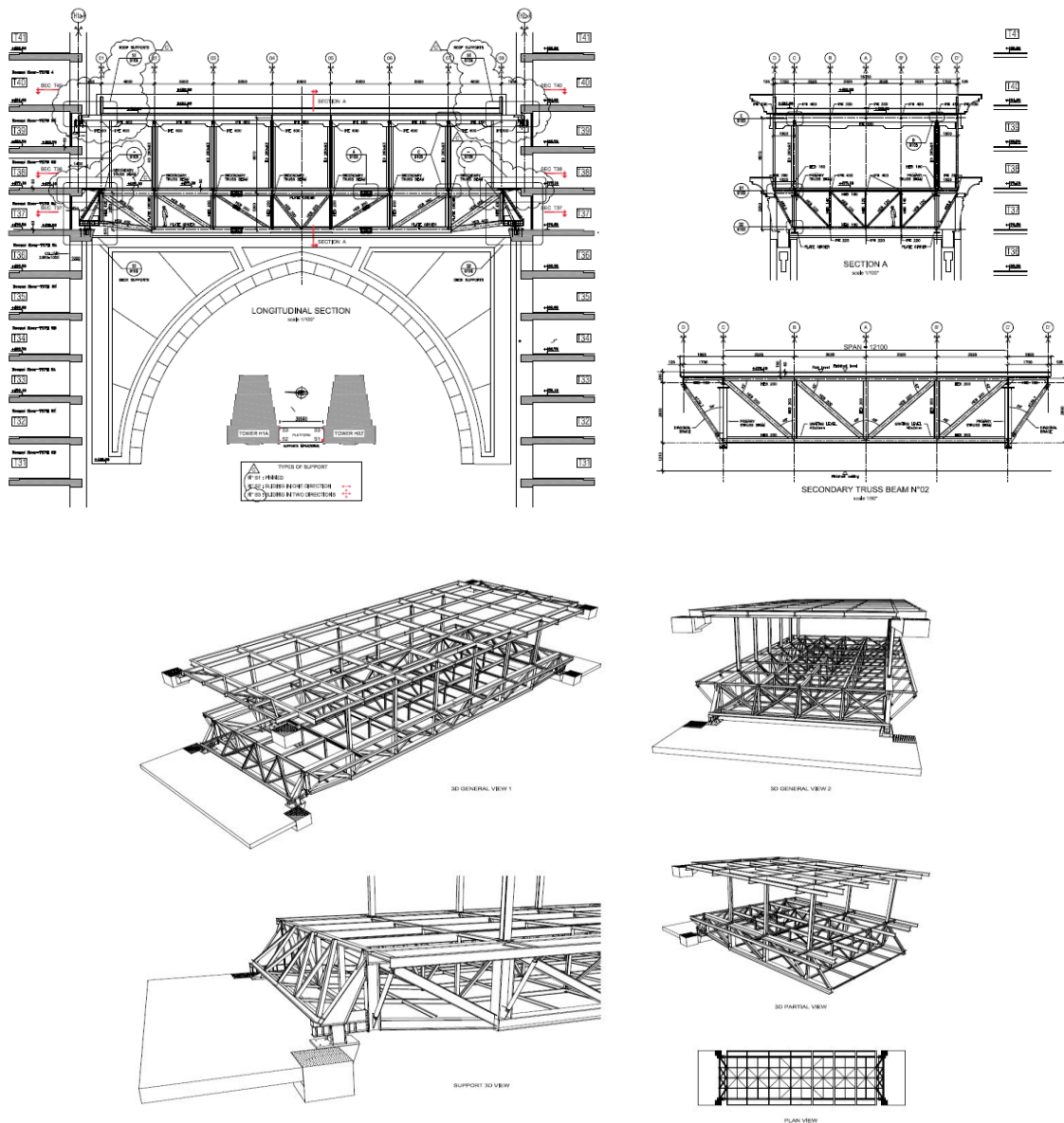


4 Jabal Omar Development Bridge Floor, Mecca, Saudi Arabia



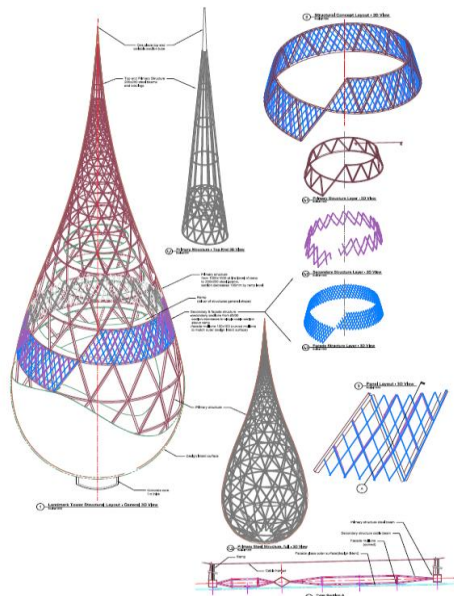
Jabal Omar Bridge Floor in Saudi Arabia designed by Arcrea

This bridge structure connects the Jabal Omar project Tours of Hotels, in Mecca. Almost 150m above the ground, it spans 37m. This 15m wide structure will house prayer-rooms with direct views over the Grand Mosque. The structure is a 3-dimensional metallic truss (bolted and welded), supported by the towers. The supports allow the two towers to freely displace one relative to the other. The project is located in a seismic zone, so coordination with the tower's structural design consultants was necessary in order to correctly define the elastic to apply on the bridge response spectrum.



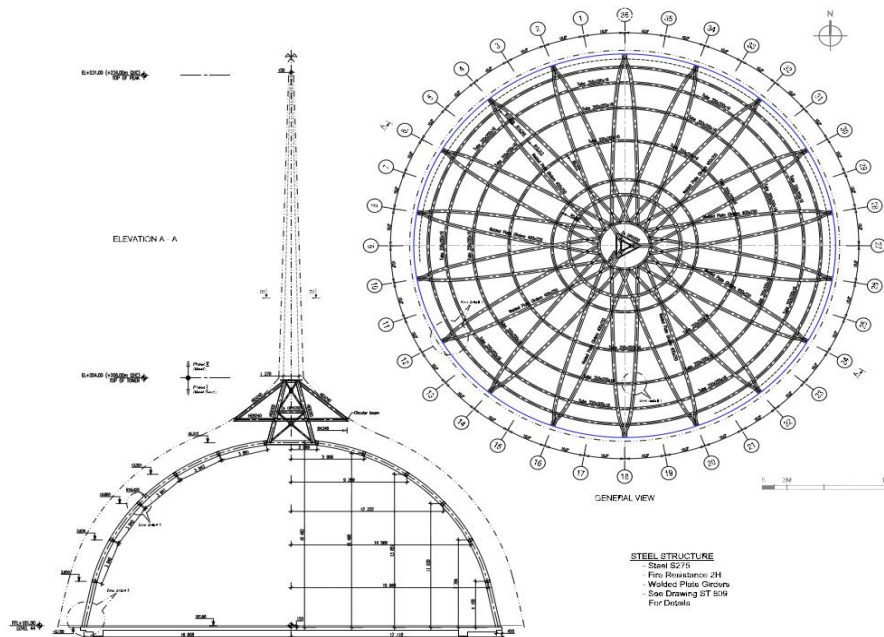
LANDMARK STRUCTURES

Lusail Iconic Structure Competition Submission, Doha, Qatar



Lusail Iconic Structure, Doha Qatar designed by xxxxxxxx

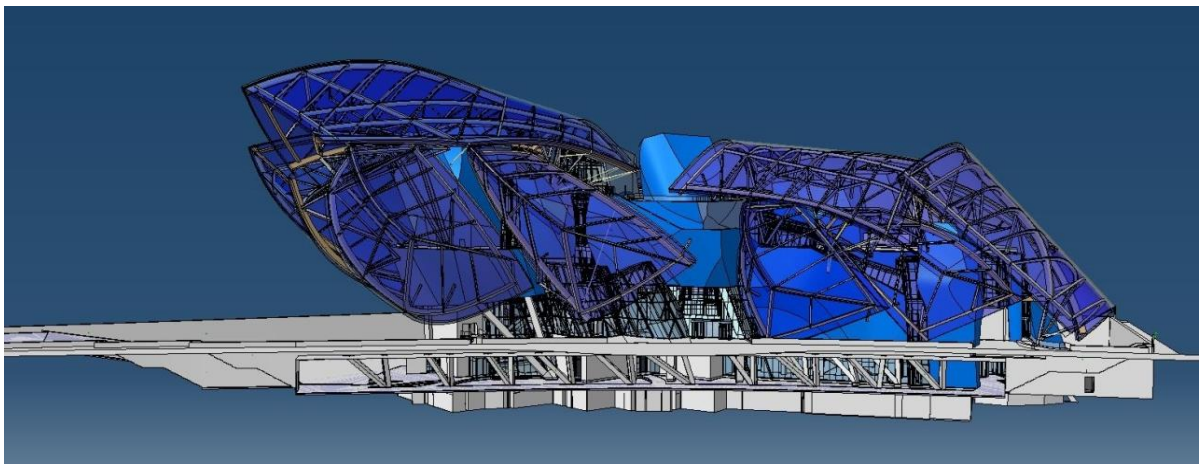
Doha Tower, Doha, Qatar



Doha Tower, Qatar designed by Jean Nouvel

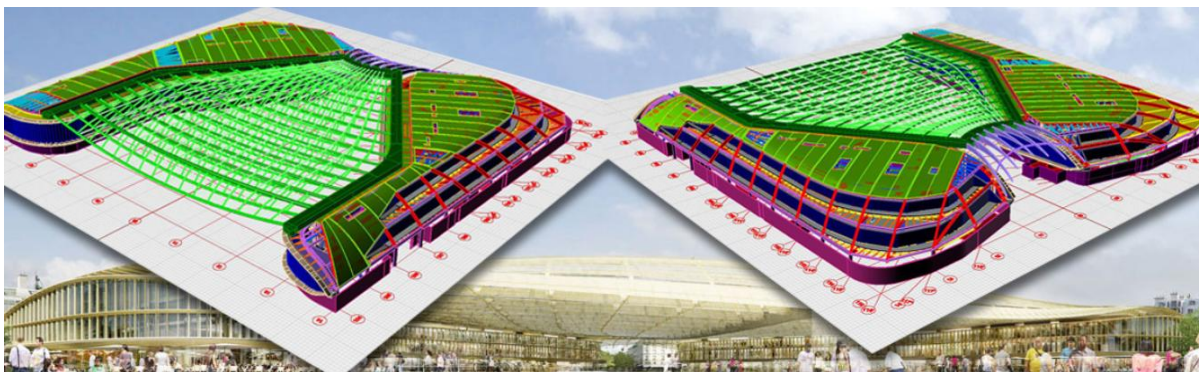
SPECIALIST BIM TECHNOLOGY

Louis Vuitton Foundation building in Paris, France designed by Frank Gehry



Terrell brief: Spatial co-ordination in 3 dimensions of the entire structure and peer review of steel structure design.

Canopy Roof of «Les Halles» in Paris, France designed by Berger & Anziutti Architectes



Terrell brief: Spatial co-ordination in 3-dimensions of the entire structure and peer review of steel structure design and glazed envelope of the 96m span canopy. Peer Review of steel structure design

TERRELL PHILOSOPHY

With today's demands of performance and economy from all construction projects, success can only be guaranteed if all parties in the construction process work together in harmony. This is why **Terrell** offers its specialist services in all facets of construction engineering: from structures to facades via building services. **Terrell's** engineers, all experts in their respective fields, are given creative freedom within the framework of a coordinated multi-disciplinary team, with the aim of delivering optimised, holistic solutions.

TERRELL are proud to provide professional services focused on technical competency and a tailor-made approach to both client and project.



Peter Terrell (Main Speaker)
President of Supervisory Board
Terrell Group
Boulogne Billancourt, France
e-mail: peter@terrellgroup.net

Zbigniew Koszut
Structural Engineering Design Specialist
Terrell s.a.s.
Boulogne Billancourt, France
e-mail: z.koszut@terrellgroup.net

Ziad Dargham
International Director
Terrell s.a.s.
Boulogne Billancourt, France
e-mail: z.dargham@terrellgroup.net