

Architecture of Engineering Reflections of Santiago Calatrava



Presentation made at the Annual SLIA Sessions 2004
Archt. Mano Ponniah

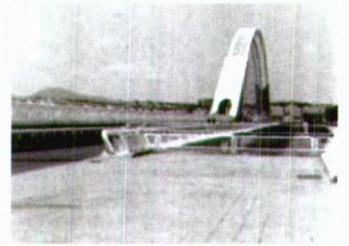
Santiago Calatrava the iconoclastic Spanish architect was unable to accept an invitation to address this distinguished gathering and I am very honored to have been asked to showcase his work instead.

I am a great fan of Calatrava and I had the pleasure of seeing his work and listening to him at the RIBA. I have also walked across one of his footbridges built in Bilbao, Spain this was a wonderful and exhilarating experience, since it was a bridge designed not in the conventional way, the use of a beam column bridge with which we are all familiar, Calatrava has revolutionized the design concepts and the method of transferring dead and live loads to the ground or to the foundations. We will understand it better when we see the examples of his work.

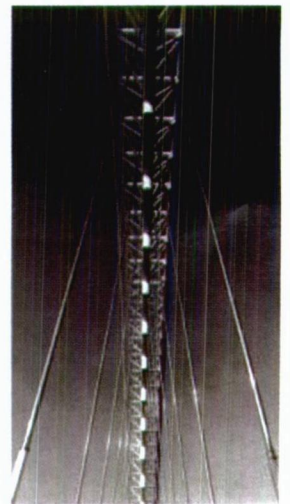
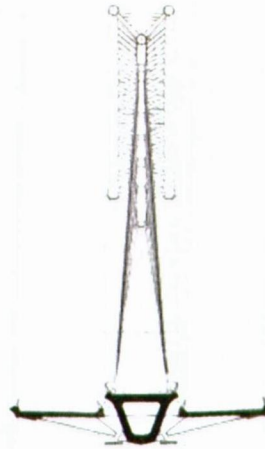
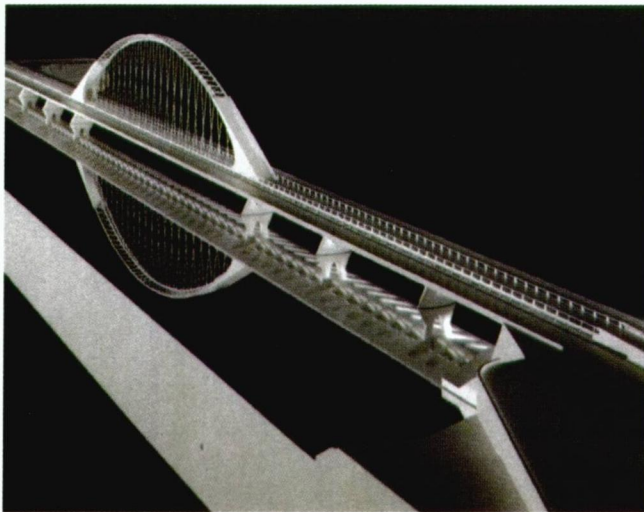
The session this year is about infrastructure, and one aspect of infrastructure is the movement of people by road, by rail, by air and the interconnection between these modes of travel, which is very critical and very important in this fast moving world and for the future development of the country. Calatrava has brought together some very exciting and fantastic engineering solutions to the demanding problems in the development of interchanges, so as we go through some of his work I hope we can draw some inspiration, and appeal especially to the young designers of the future. When the time comes and when Sri Lanka has the funds to develop this type of infrastructure schemes we hope we shall get some innovative buildings.

Just a few words about Calatrava's academic background before we look at his work. As I've said, he is a Spaniard who studied Architecture in Spain before going on to do a PhD in Engineering in Zurich. The combination of the two disciplines both Architecture and Engineering, the influence of one discipline with the other are clearly discernible in his designs and buildings. In his Phd programme he first studied the fold-ability of architectural structures and then went on to examine structural stability of these forms, and analyze them in inclined positions for structural stability. Later he researched into the pliability of structural forms for stability in space. These studies were his research exercises he later used to find Engineering solutions. I would like to summarize his approach, by saying that Calatrava destabilizes the structure and then counterbalances the loads with a variety of members, using mostly steel cables fixed to inclined arches which is further counter balanced by buttresses.,

Now we shall look at some of his work. I have selected examples of bridges and airports, canopies and railway stations to enlighten of his excellent work.



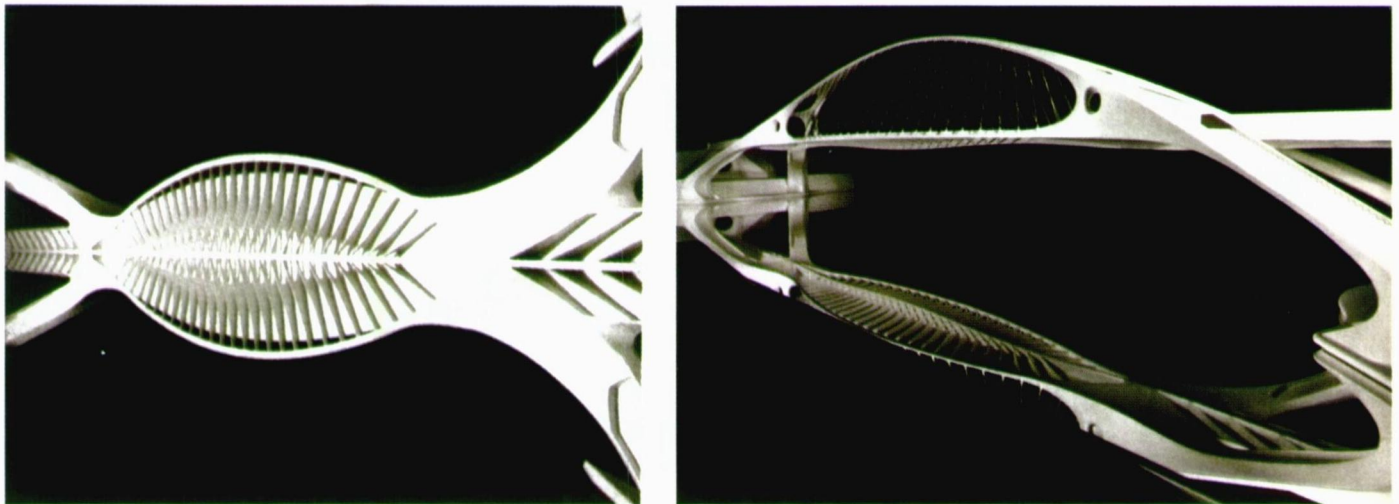
THE LUSITANIA BRIDGE, SPAIN, 1990 - 1991



THE LUSITANIA BRIDGE, SPAIN

This bridge is in Spain. The Lusitania Bridge. An arch bridge with tension cables holding the horizontal beam supporting the roadway. The overall length of this bridge is 465 metres and the central span is approximately 189 metres supported by 23 pairs of steel cables. The box girder central profile supported by cables, has cantilevers on either side for movement of vehicle, and people. The box girder forms interesting rib for the structure, an interesting profile or section....

The Cascine Bridge 1987



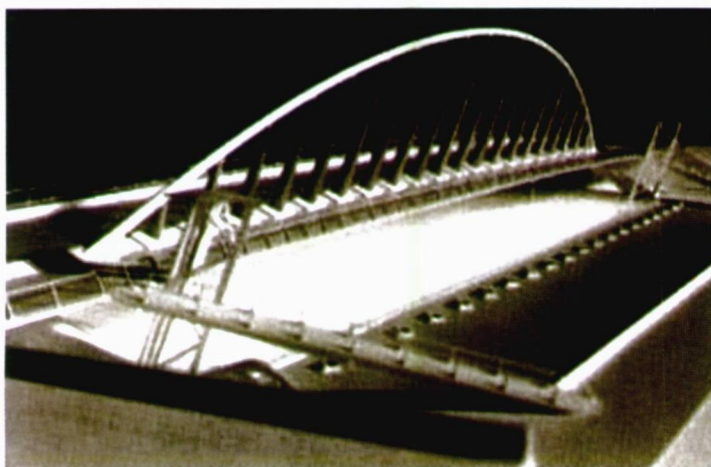
CASCINE BRIDGE, ITALY -1987

The Cascine Bridge is a project for footbridge in Florence, Italy. It has a central span of 74 metres. As you can see it is a very sculptural structure rising from four reinforced concrete buttresses with the arch and bridge beams made of steel; the suspended platform is strengthened by lateral trusses. Calatrava has a partiality for arches and for using inclined arches. He *destabilizes* the structure and then counterbalances the loads with a variety of members, mostly steel cables, as you can see from this view of the same bridge. By using the cables and buttresses on either side he has been able to achieve a very large span.

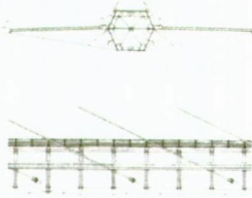
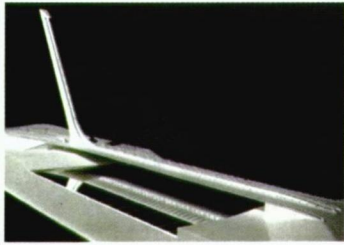
ALAMEDA, VALENCIA BRIDGE AND SUBWAY STATION

This bridge and subway station is in Alameda, Valencia – Calatrava's birthplace in Spain. It is an automobile and pedestrian bridge over the Turia River with an overall length of 163 metres and a maximum span of 130 metres.

The central span consists of an inclined arch supported on two concrete pillars. So we see the arch again tilted to a side and then the imbalance is stabilized by the loading and then tied back again to the buttresses. Constructed entirely in steel the box runs the entire length of the bridge and the structure is stiffened and stabilized by the wideness of the girder and then balanced with transfer trusses. To ensure the stability of the arch due to its lean, steel braces are placed at intervals to take the load and transmit back to the aisle. These braces are placed at about five metre centres.

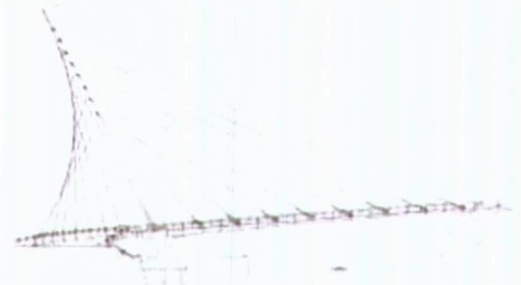
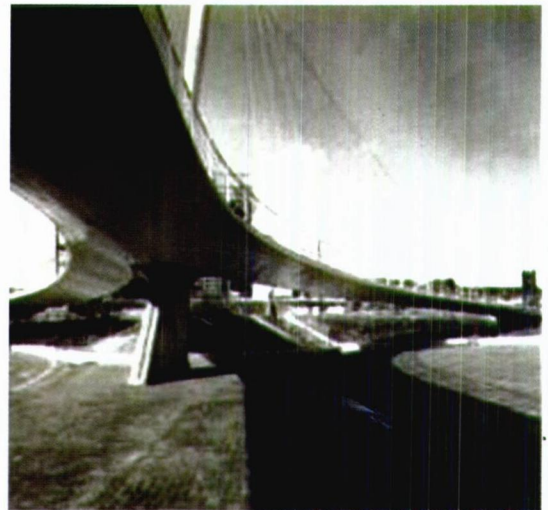


ALAMILLO BRIDGE IN SEVILLE, SPAIN 1987-1992



Commissioned as part of Expo 1992 the Alamillo Bridge in Seville, Spain is a suspension bridge with an overall span of 200 metres. The asymmetrically inclined pylon has cables supporting the main member, a hexagonal box girder which constitutes the spine and to which the thirteen pairs of cables are attached.

TRINITY BRIDGE IN MANCHESTER 1993-1995

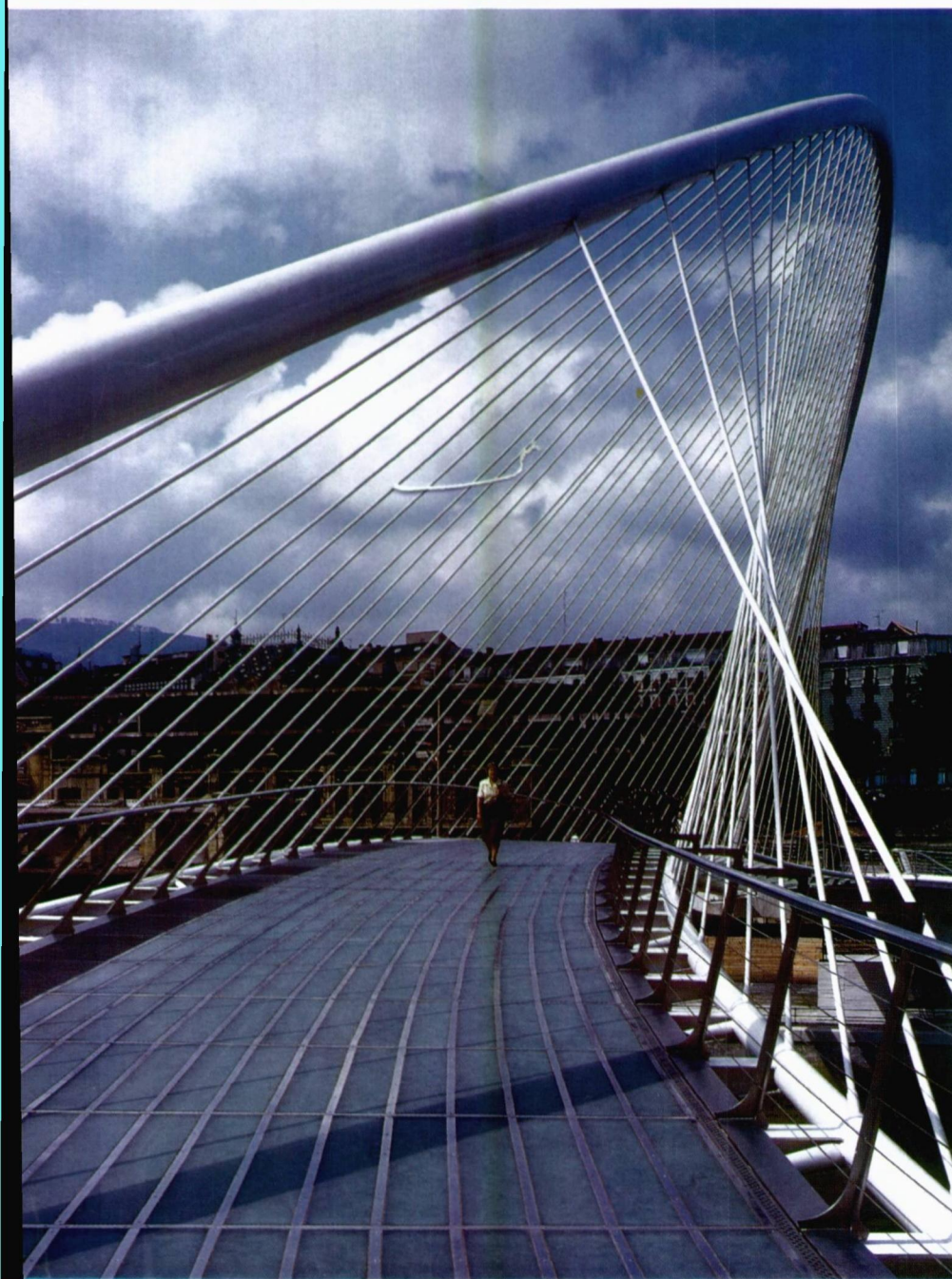


Turning now to England, we have Trinity Bridge in Manchester where he uses the same principle, the pylon and main cable supporting the arch. In this example, it consists of a triangular section box girder supported by cables from a tapered, backward leaning steel mast.

FOOTBRIDGE
BILBAO SPAIN



This is the bridge in Bilbao that I had the pleasure of seeing and walking on. The structure is still worked on the same principals, the leaning arch , cables coming down and giving support to another arch twisted around. In the second picture you can see the central rib and the other arch which comes round and is tied back to a sort of buttress. This bridge appear to be so “dynamic” and still so stable and makes a fantastic landmark in the horizon.

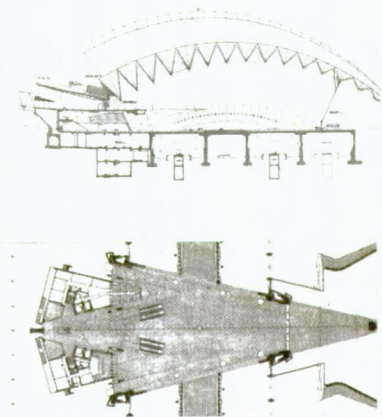
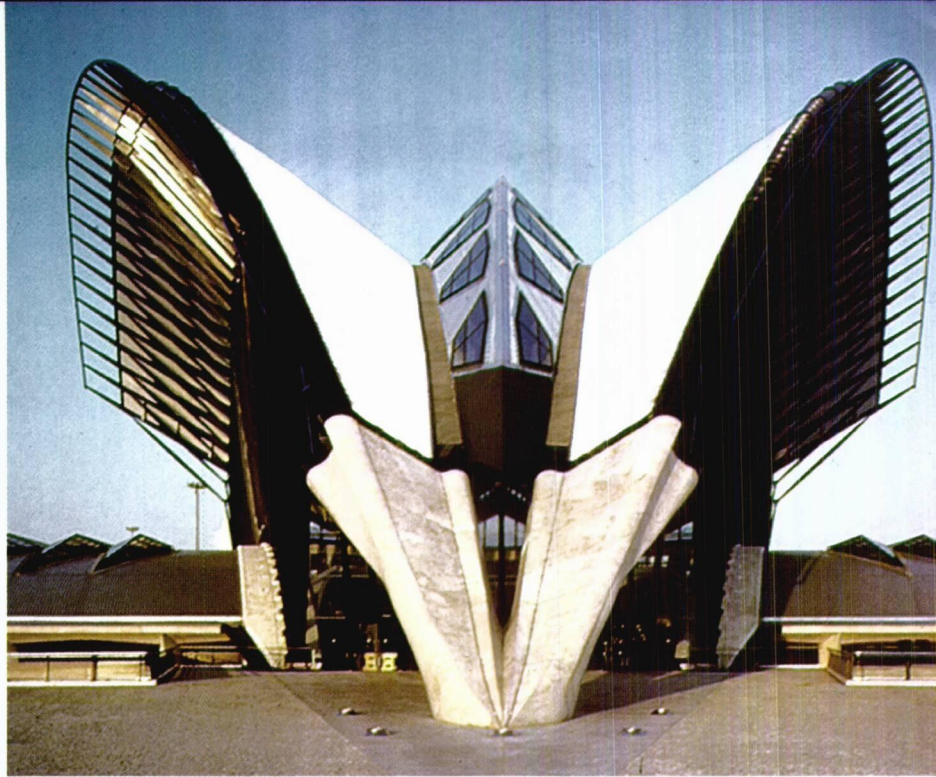


BILBAO , SPAIN, 1994 - 1997

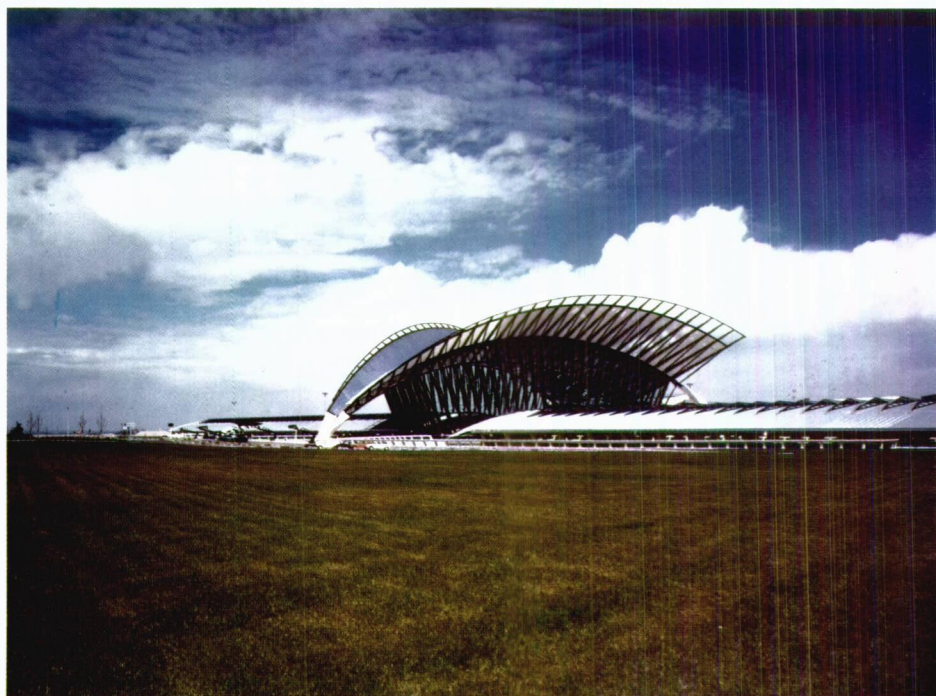
RHÔNES-ALPES,
TGV STATION,

LYON, FRANCE

This is a rail and motor interchange in Lyon, France, the Rhône-Alpes, TGV Station. for high speed trains built to serve Satolas airport. The design of the station revolves around two elements, the train tunnel and the great central hall. From the section you can see he has again made use of arches, inclined arches, fixed at the base with counterbalancing dead load structure, and then spanning between the arches are secondary beams that support the roof glazing giving a beautiful and exciting visual space underneath it. An exciting spectacle in the horizon.



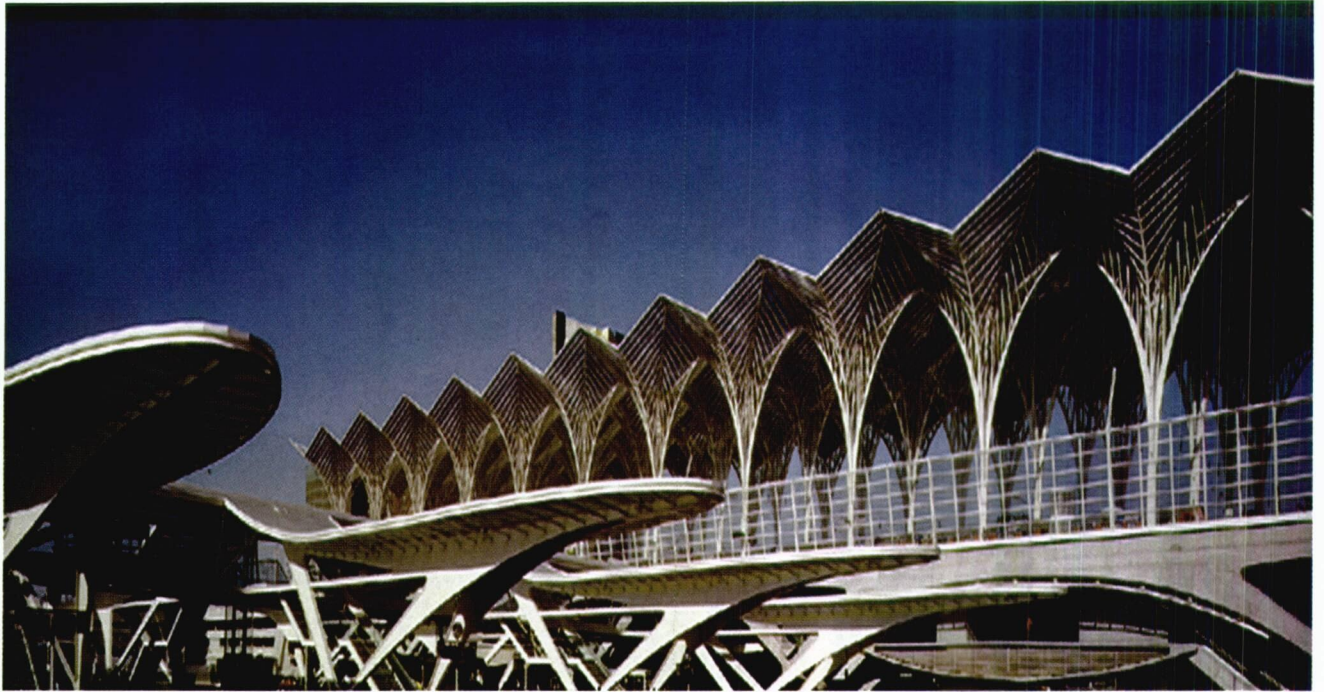
*LYON AIRPORT STATION, FRANCE,
1989 - 1994*





ORIENTE STATION, PORTUGAL 1993 - 1998

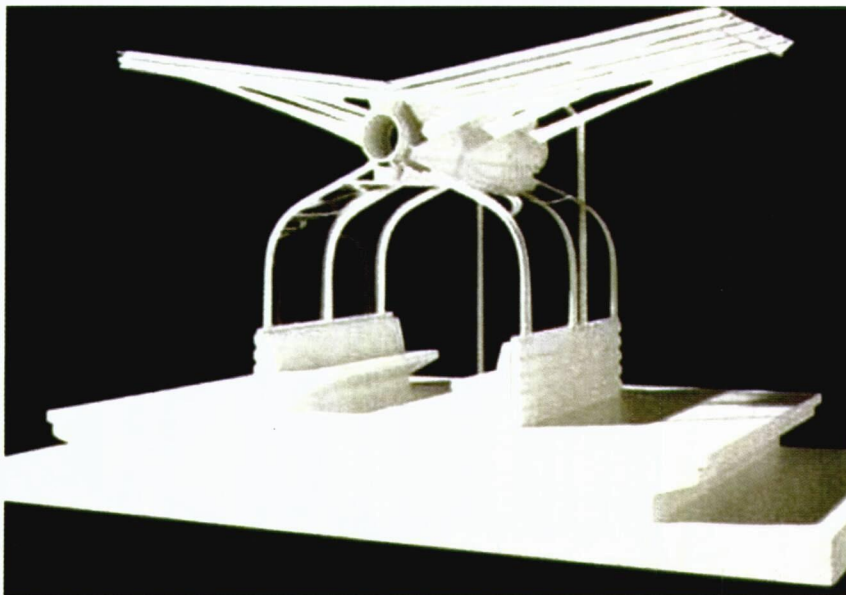




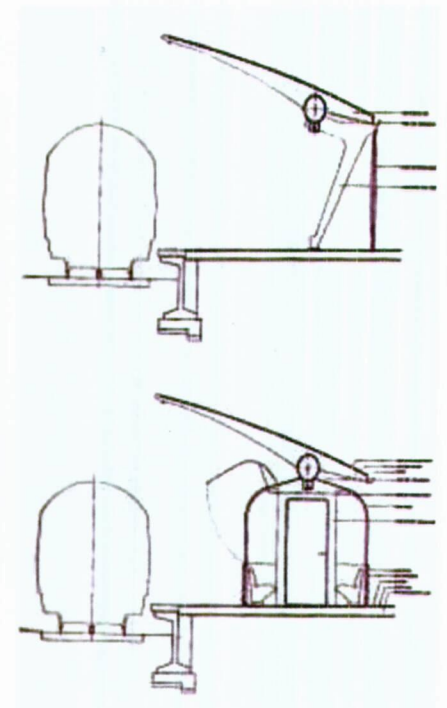
ORIENTE STATION, PORTUGAL ,1993 -1998

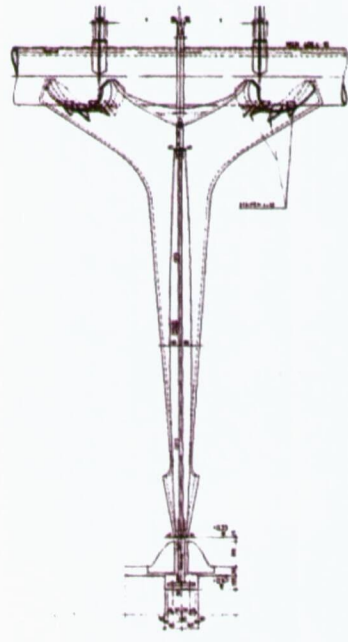
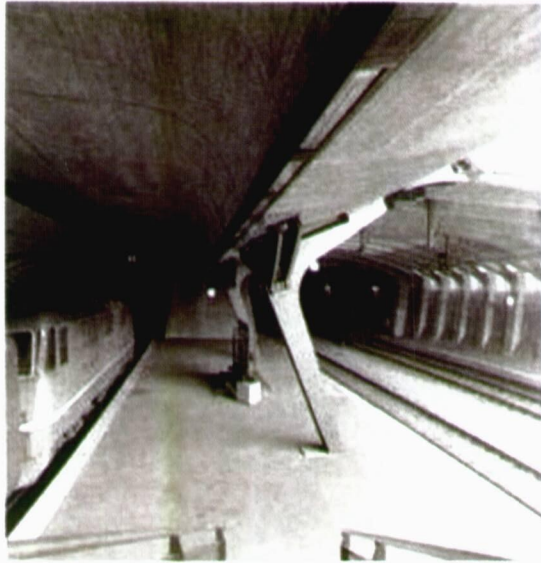
Oriente Station, Lisbon Portugal

This is another example of an Interchange Station, the Oriente Station, Lisbon Portugal. Constructed as an interchange between bus and train and to facilitate the reception and flow of visitors during Expo 1998, the bus station is distinguished by a sequence of glass and steel canopies that connects it to the train station which is covered by a modular steel structure with interconnection to other areas and transportation facilitated through a system of glazed galleries.



SUBWAY STATION, LONDON - 1992





TRAIN STATION , SWITZERLAND, 1983 -1990

Subway Stations Switzerland & London

Two examples of Sub-way stations where Calatrava makes use of cantilevers and pipework detailing to give importance to structural principals.

Orleans Bridge France

This is another wonderful example of a Calatrava bridge built in France.(pic oppisite page)

Singhalese Sports Club Colombo

Now to turn to Sri Lanka,. Dambulla Stadium is a recent example where the Architect has tried to achieve a large covering roof with a structure where the metal roof is supported by a frame work of steel beams with ties at the top, pulling it back to pylons. We are pleased that there is still hope that there is some attempt to try out new ideas for structural solutions. Just to go back about that so we have been able to achieve very big spans there.

We recently did two Projects for the Sinhalese Sports Club, our main Test cricket Playing Ground The brief was to improve the existing facilities, both in the Media Centre and the Communication Centre, and we solved the structural loading problem by providing a framework of steel columns to which we tied back the TV Camera deck, and the roof.

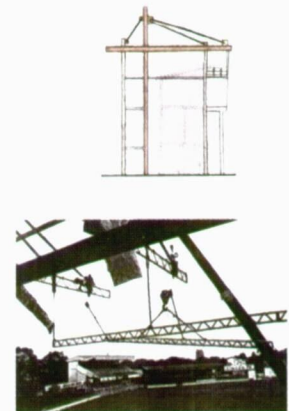
I think that is the furthest we have tried to progress in doing something interesting within the budget limits that is provided by the Clients, and we hope that the steel structures will be suitably maintained..

Conclusion

I hope that with the impetus for Infrastructure development with both local and foreign funding will encourage future Designers to think differently and find innovative solutions to Structural and Architectural briefs.▲



S.S.C.MEDIA CENTRE, COLOMBO -2001



S.S.C.COMUNICACION CENTRE, COLOMBO -2001

This is another wonderful example of a Calatrava bridge built in France



ORLEANS BRIDGE FRANCE, 1996 - 2000

