ME - SSP

شركة المنشآت ثلاثية الأبعاد المحدودة

SPACE STRUCTURES Company Ltd.

Tamimi Safeway

Public Administration Institute
Dammam

Aramco Gas Station

Saudi-Bahrain Causeway

Nadec-Haradh

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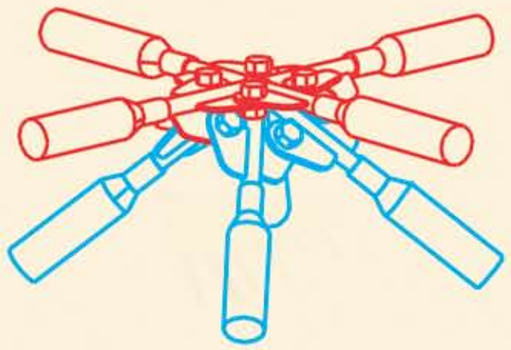
ME-SSP® Space Frame System



Flange 5

The Space Structures Company (SSC) Ltd is pleased to present the **ME-SSP®** Space Frame System, a result of an innovative process of our Research and Development efforts for the past decade.

The **ME-SSP®** Space Frame System is based on Multi-hinge concept (originally conceived in USA and marketed as Pearce Systems International Inc.), and offers a structurally efficient joint system that could be designed to any degree of moment and axial force capacity.

The major developments achieved are twofold, one being the incorporation of a diametric transition zone to facilitate a lesser eccentric placement of connecting bolts. This is constructed by swagging of pipe ends to merge onto inserted solid metallic rods.

The other innovation was a fabrication format where the three-dimensional geometric form is mapped onto a two-dimensional cylindrical coordinate system. This has greatly simplified the fabrication of complex geometric forms, thus rendering a cost effective **ME-SSP®** Space Frame System.

This presentation highlights the attributes of the **ME-SSP®** Space Frame System. The structures presented cover a wide range including Entrance Canopies, Roofs of all types providing shades over Security Gates, Swimming Pools, Building Courtyards and School Compounds.

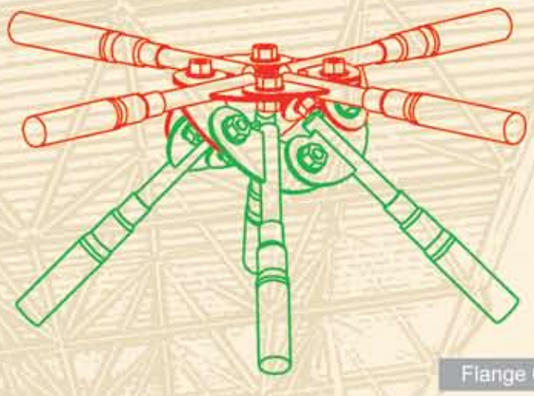
A modern trend is for architects to create buildings and public spaces that are novel and inviting, by formulating designs that exhibit far more curvature than has been seen before.

The space frame structures allow any architect to affordably add a statement to the structures he designs. This is exemplified in frequent use of space frame structures to provide the theme at many entertainment, recreational and commercial facilities.

One of the essential advantages of space frame structural systems is their relative lightweight, especially for large span roofs where the self weight constitute a major component of the total load. The lightness of the space frame members contribute to the rationality and economy of the structural system.

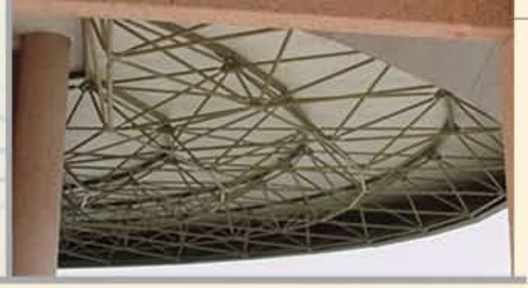
Production and construction techniques of spaceframes are industrialised to a greater extent than in any other conventional structural system. The linear elements are prefabricated so that the jointing work at the site is relatively simple.

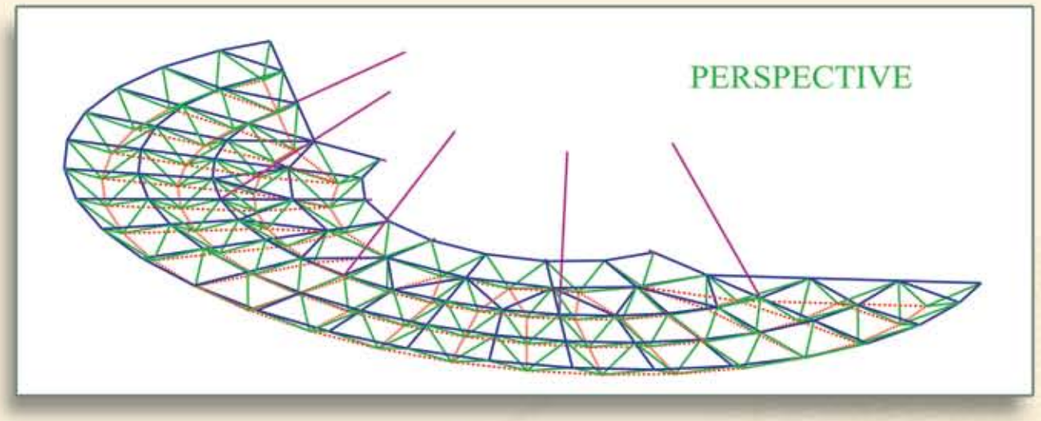
The lightweight of the individual elements contributes to significant reductions in the cost of transport and erection. In addition, space frame structures are sufficiently stiff in spite of their lightness due to the inherent three dimensional character and to the full participation of the constituent elements.

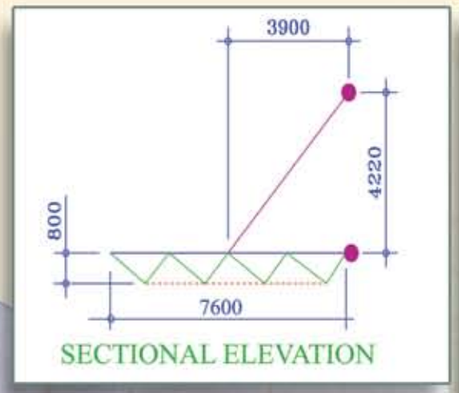


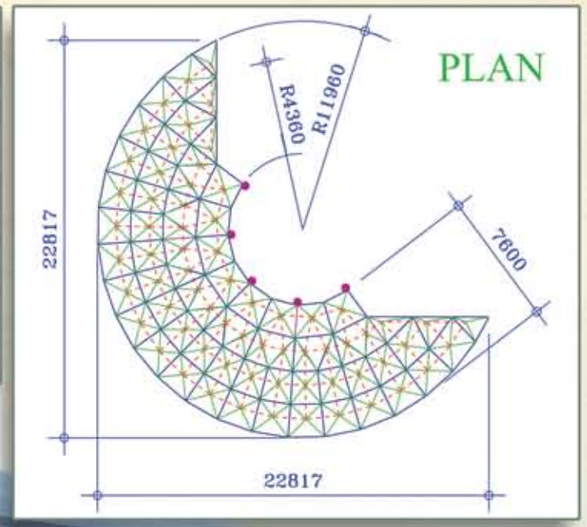
Flange 6

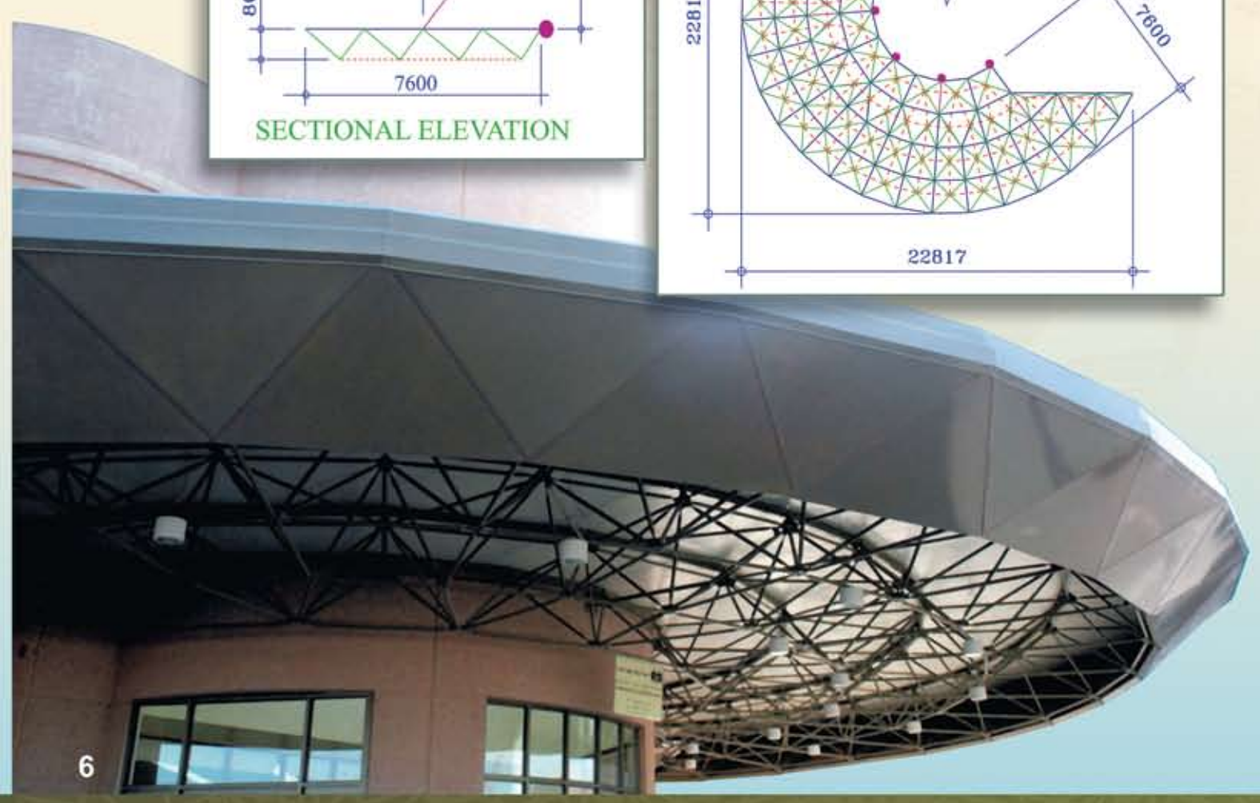
Tamimi Supermarket Entrance Canopy, Dammam





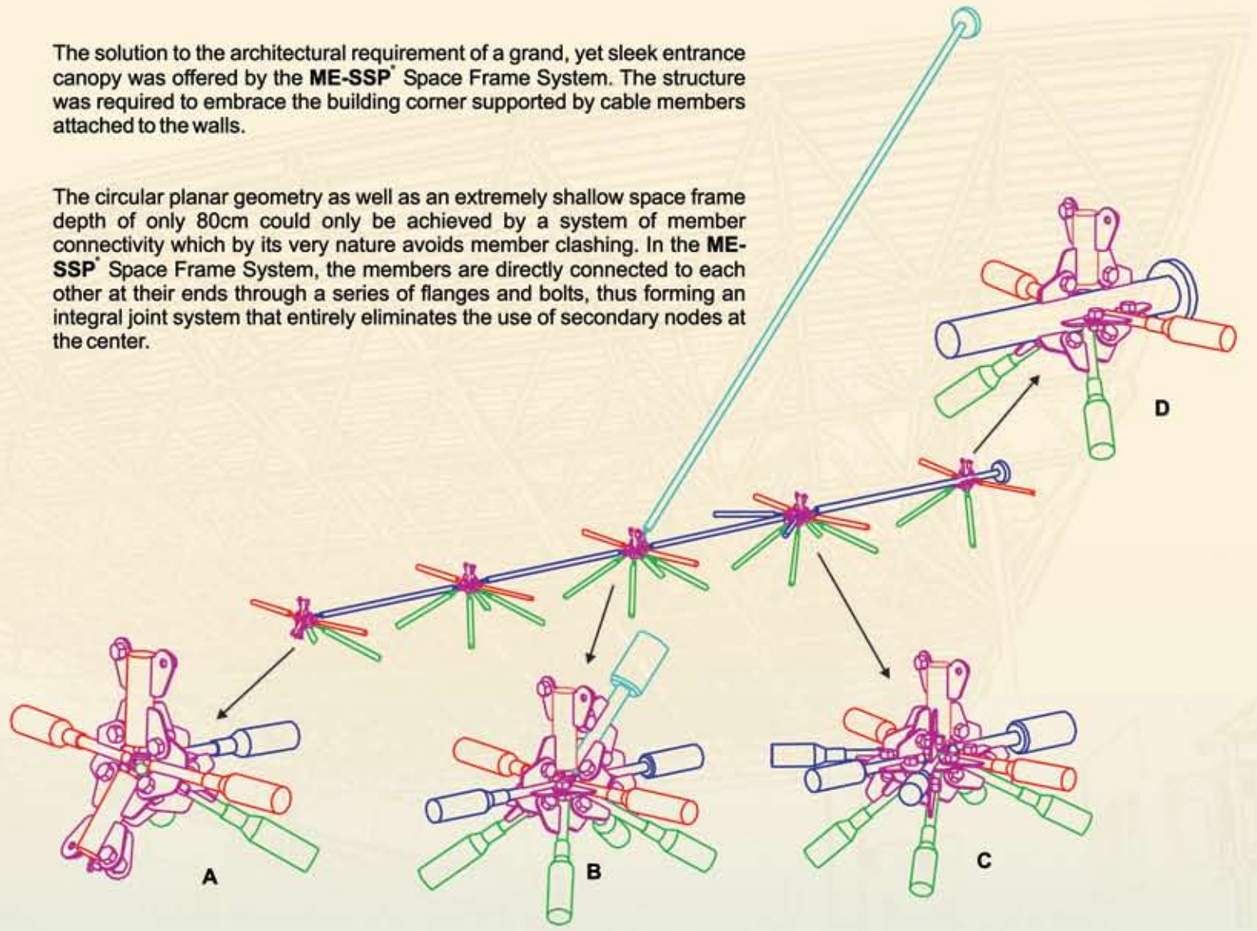






The solution to the architectural requirement of a grand, yet sleek entrance canopy was offered by the **ME-SSP®** Space Frame System. The structure was required to embrace the building corner supported by cable members attached to the walls.

The circular planar geometry as well as an extremely shallow space frame depth of only 80cm could only be achieved by a system of member connectivity which by its very nature avoids member clashing. In the **ME-SSP®** Space Frame System, the members are directly connected to each other at their ends through a series of flanges and bolts, thus forming an integral joint system that entirely eliminates the use of secondary nodes at the center.



A) The apparent concentration of mass at the joints of the **ME-SSP®** Space Frame System gives a pleasing aesthetic appearance. The numerous bolts available at the joint also allows easy connection of accessories and cladding systems.

B) The member connectivity criteria can be defined to accommodate any number of members inciding at any specified angle. This flexibility in design means any concievable geometric form can be accomodated.

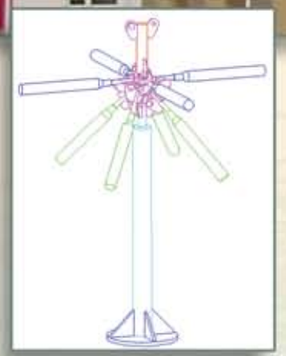
C) The multiple load path allows the diffusion and distribution of forces through shearing of bolts, which can be properly designed for by selection of connecting bolts sizes and flange thicknesses.

D) The ability of the **ME-SSP®** Space Frame System that allows any member to traverse continuously through a joint, means that the member can be designed to resists moment and shear forces.

For Tamimi Entrance Canopy Structure, the result was the merging of the horizontal support shaft to the top chord member, thus permitting anchoring of the structure onto the vertical wall.

FLANGE 6

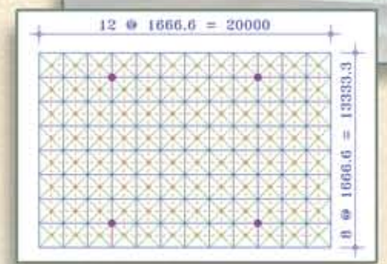
Shades Covering Gas Stations



The short steel columns have been designed to support the Space Frame Shade on its top chord, and proportioned so as to allow the larger size concrete columns to be partially embedded into the space frame. The result was an aesthetically pleasing structural envelope covering this Abdul Aziz Al-Abdul Karim Gas Station in Dammam.

The flexibility offered in the member connectivity, by the **ME-SSP**® Space Frame System removed the need to merge the support shaft with the purlin stool as is the normal practice. Instead the support shaft is ended with a cap and a 30-mm steel rod, with the purlin stool connected to the top chord members. The resulting uniformity achieved was thus characteristic of Space Frame Structures.

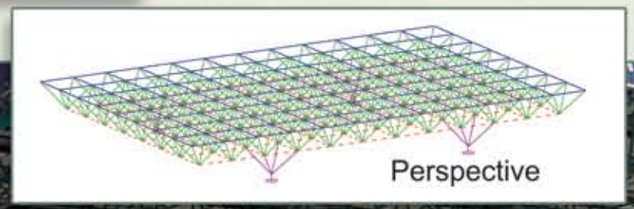
The purlin stools are designed to achieve a slope in the cladding to allow drainage. The purlins whose ends are bolted onto the purlin stools allow attachment of accessories, particularly the facias, giving an architecturally accepted finish to the Space Frame Shade.

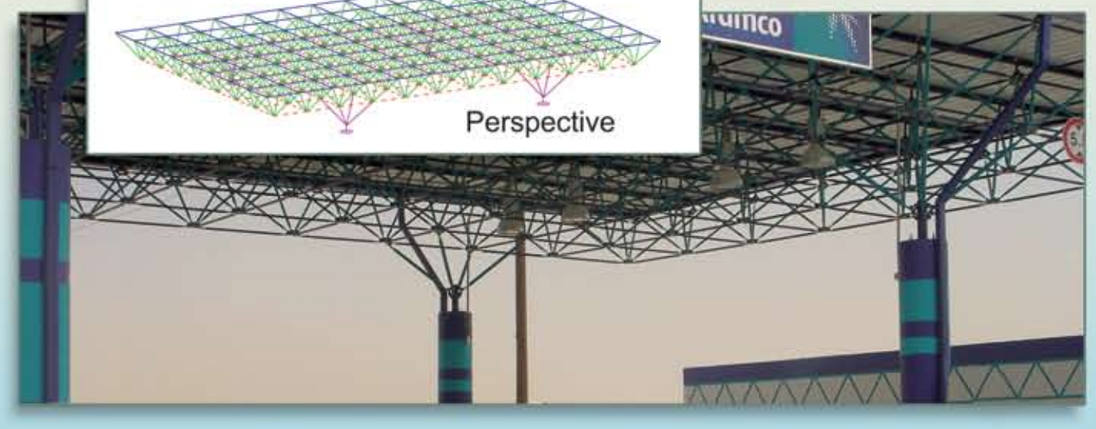


The **ME-SSP**® Space Frame System was the ideal solution for a light structural covering over this Saudi Aramco Gas Station.

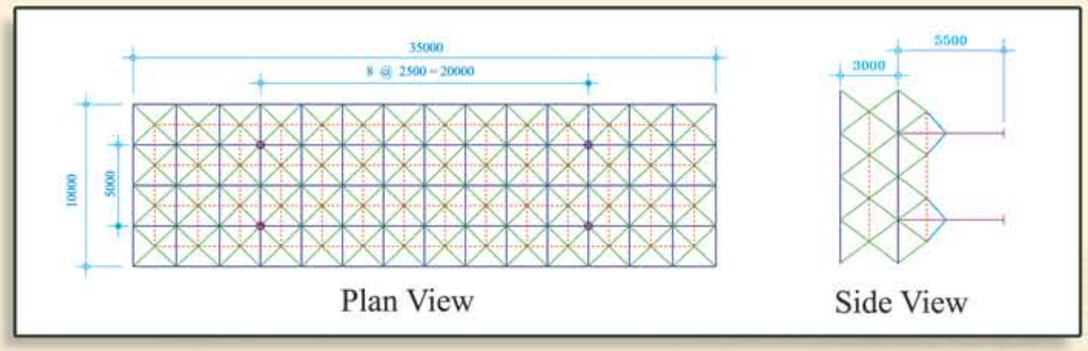
The shade has been supported on four short steel columns welded onto base plates which in turn are anchored into reinforced concrete columns. Four drop-down diagonals frame into the top of the short support columns, thus offering an efficient support system to the structure.

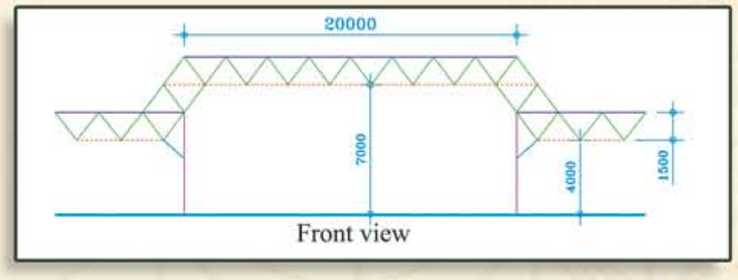
The location of the supports has been optimized to not only provide sufficient space for the service bays, but also facilitate a cantilevering effect, the result of which was the reduction in the total weight of the structure, and therefore the cost.

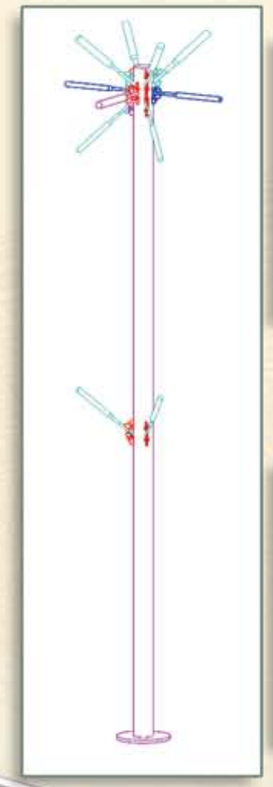


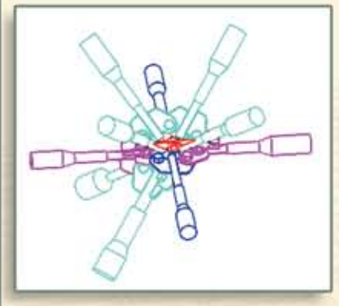


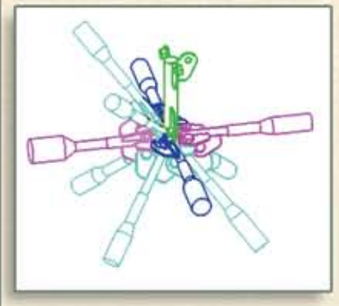
Entrance Gate Shade of Nadec Farm at Haradh











The shade over the Entrance Gate House of the Nadec Farm at Haradh was required to cover a total area of 35m x 10m on four support steel columns.

In the geometric design of the structure, and noting the advantageous use of cantilevering as a way of allowing the structures to span further, the innovative incorporation of a multi-layered format, resulted into an optimized structural form that met the client's expectations.

The **ME-SSP®** Space Frame System achieved the complex member connectivity and offered that aesthetic appeal so essential to this structure.

The 'wing-form' cantilevering arms do present a strong architectural statement and a welcoming beacon to this farm in the middle of the desert.

A noteworthy originality in design, the **ME-SSP®** Space Frame Support Column System was able to be simple, inexpensive and design wise integrated as a design element or member directly within the scope of the **ME-SSP®** Space Frame System interactive design.

Given that the support system is designed in a manner of the space frame members, an overall equilibrium is desirably ensured right up to lower load bearing elements in a consistent manner.

The multi-hinge jointing system that constitutes the **ME-SSP®** Space Frame System offers the outstanding advantage of a good balance between forces in the members and the capacity of the joints to deliver them right up to the supporting elements.

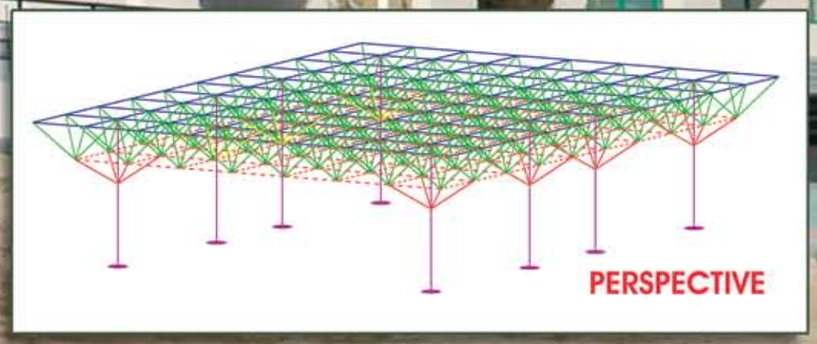
This leads to considerable savings of materials and hence reduced cost and self-weight of the space frame.

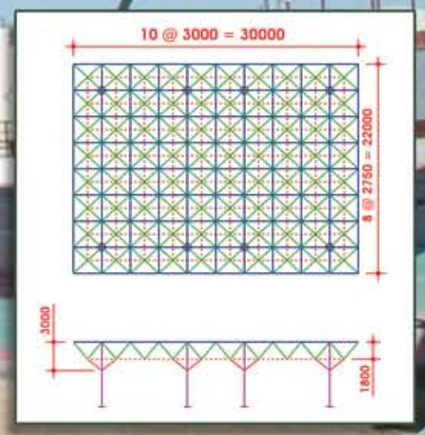
KFUPM School

The **ME-SSP®** Space Frame System shade over the courtyard of this Boys Elementary School owned by the King Fahd University of Petroleum and Minerals (KFUPM), offered an ideal and economical solution for a playground.

A roof 30m x 22m consists of a double layer space frame supported on eight columns on the top chord and provided with drop down diagonals as additional bracing.

The design provided the optimum answer to the demand for appreciable savings in the use of material and management and hence superior economy which enabled the whole project to legendarily fall within the client budgetary constraints.
It is very hard to envisage a covering system that can compete with the **ME-SSP®** solution with regard to cost and longevity.





Imposing Entrance Canopies

The placement of a unique "wave" form of uncovered Space Frame in the front and sides of this building, not only added tremendously to its beauty, but resulted into an architecturally acceptable aesthetic appeal that placed this site into a landmark in the city of Al-Khobar.

The **ME-SSP®** Space Frame System has been able to economically follow the complex geometry that was based on an approximate sinusoidal shape both in plan and elevation.

The project required an elegant support system. Provision of typically two long members anchored into the vertical wall at variable elevations addressed this requirement. The simplified format of the support is typical of the **ME-SSP®** Space Frame System where its design and construction is integrated and forms an inherent part of the whole structure design and fabrication.

The illustration shows an entrance canopy to this showroom in Dammam for high ended Hyundai motor vehicles. The structure is supported on four supports, two on the top chord and the other two in form of two 'cable' members anchored onto the wall above the space frame and the other ends connected to top chord.

The apparent concentration of mass, characteristic of the **ME-SSP®** Space Frame System gives a pleasing aesthetic appearance, which was a necessary requirement for an entrance canopy to such a prestigious showroom.

Najran Cement Factory
Entance Canopy to Restaurant

Below is shown a curved canopy at one of the entrances of the Al-Mana Hospital in Al Hassa. The effect to the building was so successful that the client ordered three more similar canopies to cover the remaining entrances.

The entrance canopy to the Restaurant Building of the Najran Cement Factory (shown as a wire model above and as a completed structure at the top right corner) presented a special challenge as its geometry is of a double curvature constituting circular arcs in plan and section.

The support system was designed as vertical columns with two 'cable' members connected to the top chord of the space frame structure and one cable anchored onto the roof top at the back of the structure. The **ME-SSP®** Space Frame System achieved this through it capability to handle bending element integrally

The cladding made up of Aluminum Composite Panel, 4-mm thick, was specially fabricated and tailored to fit the double curvature.

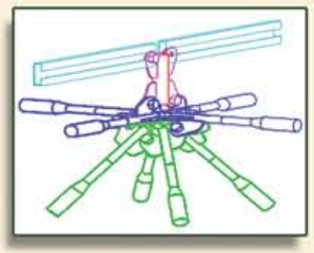
Bahrain Causeway Gate House

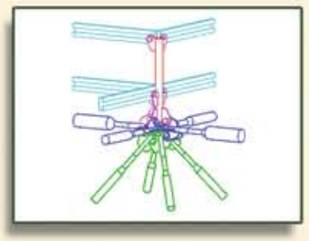
Accessories and Attachments

The Purlin Stool has been specially designed and configured to fit on one end into the joint system thus enhancing its strength and confinement, and on the other end to accept a framing of purlin profiles from any given direction.

The length of the Stool can be varied to achieve any slope. This results into an integral structural system where by the very nature of its connection to the space frame, the purlin/glazing system increases the overall structural performance.

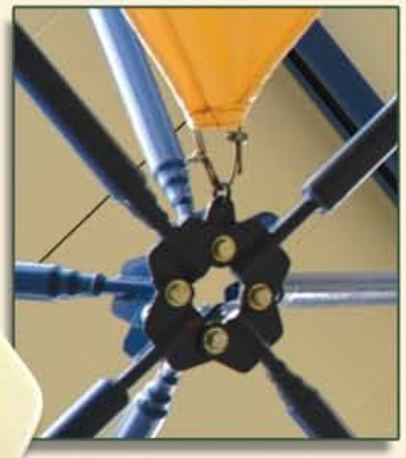
An innovative adaptation of the standard purlin stool to accept multiple purlin framing lead to the provision of Monitor Lighting for this space frame shade

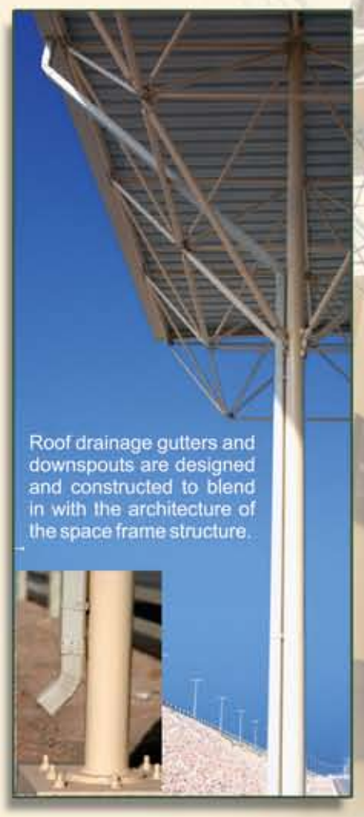




The multi-hinge connection joint of the **ME-SSP®** Space Frame System allows easy attachment of tensile fabric structures using the same bolts as used in the flange connections.

The placement of multi-colored tents in selected modules added an aesthetic flavor to this multi-purpose hall built over a courtyard in the Public Administration Building in Dammam.





Roof drainage gutters and downspouts are designed and constructed to blend in with the architecture of the space frame structure.

The Support shaft is designed as a short column, and therefore able to carry large axial forces.

Detailing of the support bases is greatly simplified to allow fixation to supporting structures like steel corbels.

School Shades in General

This 32.2x14.4m outdoor space frame covering, also serves as a sports ground for this Orbit Boys School in Dammam. With a depth of 1.5m, the **ME-SSP®** Space Frame System was able to provide a cost effective solution.

The roof effectively spans in one direction, with one set of supports anchored into the wall and the consisting of relatively short columns below four drop down diagonals.

The need to cover the entrance, in a tight fitting area of this Al-Hussan School in Dammam, was adequately addressed by the **ME-SSP®** Space Frame System.

The shed rests over two steel columns on the front supported on the bottom chord, and three short columns supported on the top chord, and anchored on the building roof slab behind the parapet.

This 34.125x21.42m indoor space frame covering, not only serves as a sports arena, but also doubles as a multipurpose hall for this Noor Al-Islam school in Dammam.

The variable coloring of the members, input into the **ME-SSP®** Space Frame System as a parameter, gave a more pleasing artistic innovation.

The **ME-SSP®** Space Frame System has been acclaimed by the owner of the Dhahiya School in Dammam, as the best solution to cover this interior multipurpose hall.

The shed is supported on short steel columns on the top chord and anchored on the wall ring beam.

The cladding at the top consists of sandwich panels to provide adequate insulation placed over purlins whose drainage slope is provided by variable purlin stools heights.

The **ME-SSP®** Space Frame System shed over this Infant Girls School in Dammam has been designed over four short steel columns below drop down diagonal members. The roof covers an area the size of 20m square.

The **ME-SSP®** Space Frame System shade over the courtyard of this Boys Elementary School in Dhahran covers an area 30x22m and is supported on eight columns on the top chord and provided with drop down diagonals as additional bracing.

Decorative and Special Structures

A combination of the standard **ME-SSP®** Space Frame System and the conventional steel construction using large pipes and large connection flanges with multiple bolts, resulted into this imposing Electronic Signpost Stand for the Al-Hadeed Factory in Jubail.

The structure pleasantly blends in quite well with the landscaping design giving an overall balanced environmental and architectural concept.

The 9 meter high structure consists, in the upper right corner a double layer grid geometry with a modulation of 700-mm modulation and space frame depth of 500-mm. The lower left corner is constructed of a single layer, demonstrating the immense capability and flexibility that **ME-SSP®** Space Frame System offers.

The picture shows the One-meter decorative dome, at top of a monument in front of the Al-Jumah City Center Mall in Al-Khobar.

From geometrical point of view, the ability of the **ME-SSP®** Space Frame System to offer tight modulation that meets the "spherical-excesses" -an essential tensigrity criteria necessary for a realization of a dome in the first place - is almost unrivaled by any other system especially when considering small radius domes and elimination of structural instabilities in single layer domes.

From aesthetic point of view, the **ME-SSP®** System gives an optical effect of an array of flange pattern where the flange connections give a well dignified look and hence ample aesthetic merit to this single layer small radius dome structure with which it forms a harmonious ensemble.

The picture shows an entrance canopy to a children's hospital in Burkina Faso, in the Sub-Saharan Africa. The construction of the **ME-SSP®** Space Frame System did achieve the architectural and aesthetic requirement of a simple yet imposing structural form, to serve as a welcoming entrance.

The erection into place of this structure by unskilled labor in a remote part in Africa, demonstrates yet another attribute of the **ME-SSP®** Space Frame System. The member assembly is guided by a simple 'erection drawing'. For the case of Burkina Faso, the erection was completed in time by the local contractor.

An overhead view while below the entrance of the Noor Al-Islam school in Dammam, reveals this spectacular sky-line projection of this uncovered decorative dome, placed over a circular opening in the roof of the entrance.

The standard flange connectivity characteristic of the **ME-SSP®** Space Frame System for this single layer dome, accentuates that circular joint geometry in conformity with the dome geometric form.

The hemi-spherical dome has a diameter of 3.360-m at the base and has a height of 1.830-meters.

Space Frame Structures over Security Gates

The **ME-SSP®** Space Frame System shade supported on eight short steel columns which in turn are anchored into large and tall concrete columns, results into an aesthetic blend, befitting this security entrance gate of the Najran Cement Factory located at Sultana (Outside Najran).

The need to provide protection from the sun to the automated personnel checking equipment of this security gate belonging to Hadeed Company in Jubail, was addressed by installing a 19-m by 14.25-m **ME-SSP®** Space Frame System roof structure. The modulation size of 2.375-m with a system depth of 1.4-m was used.

Overall structural stability and efficiency has been optimized by the use of drop-down bracing diagonals to the four steel support columns.

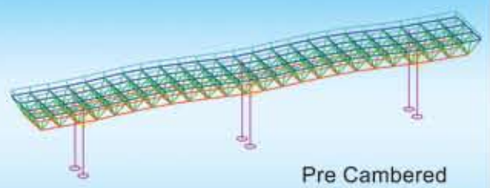
The 14.85-m by 9.90-m shade over the security gate-house of the Najran Cement Factory at Najran constructed using the **ME-SSP®** Space Frame System, was able to achieve a space-frame depth of only 825-mm with a modulation size of 1.625-m.

Perhaps one of the most elegant space frame structures to be built out of the **ME-SSP®** Space Frame System yet, is this shade covering the VIP Immigration on the Saudi side of the Saudi-Bahrain Causeway. A similar structure is erected on the Bahrain side of the border.

The overall elevation given by the tall steel columns supporting the structure on the top chord, gives this shade a sense of magnificence befitting a VIP handling.

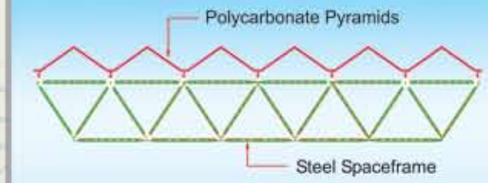
One of the innovations in this structure is the modification of a set of purlin stools to allow multiple purlin framing, resulting in increased lighting and aeration.

This space frame shade over the entrance to the school in the Najran Cement Factory compound is supported on short steel shafts, on top of concrete columns. The structural functionality and architectural intent was adequately covered by the **ME-SSP®** Space Frame System.

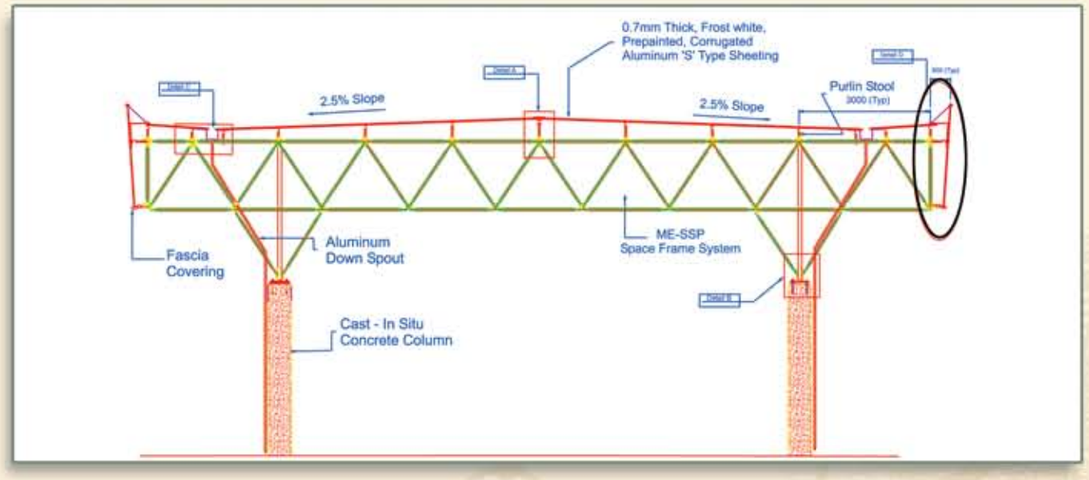


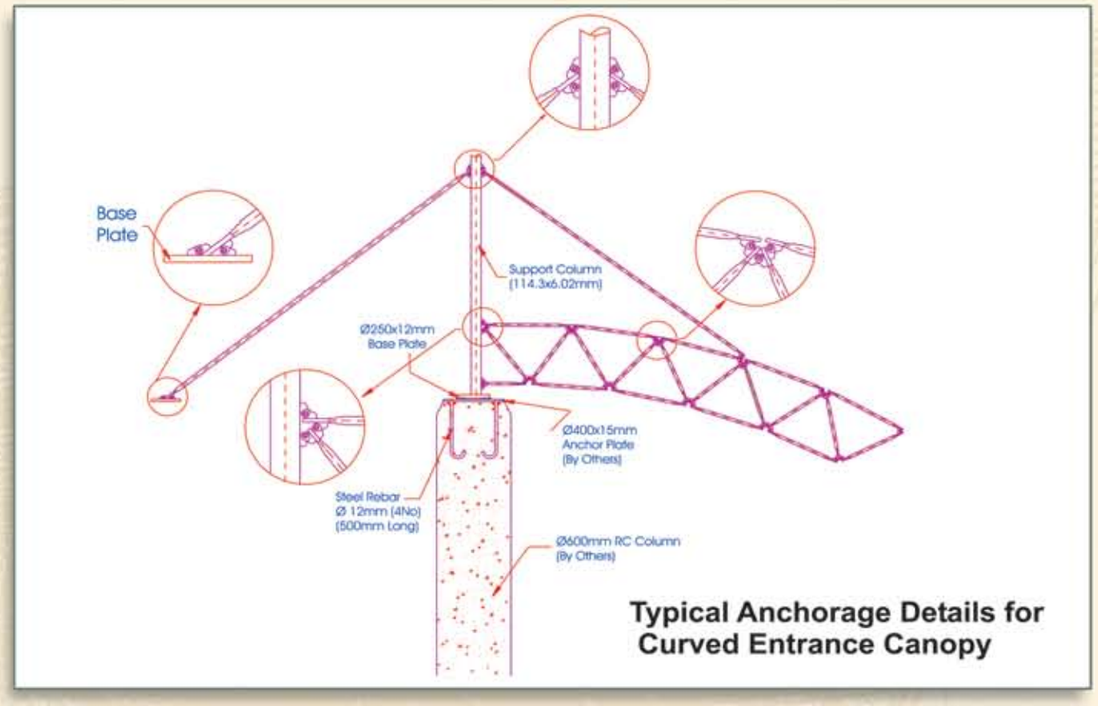
Pre Cambered
Car Park Shade

Sketches of Standard Attachments and Accessories

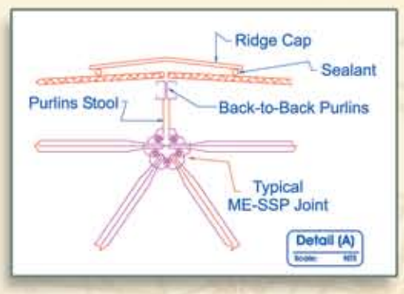


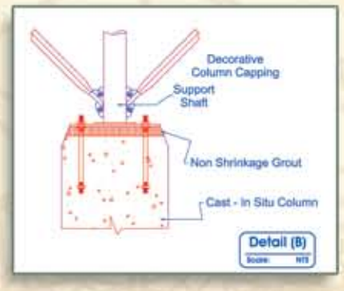
Skylight System

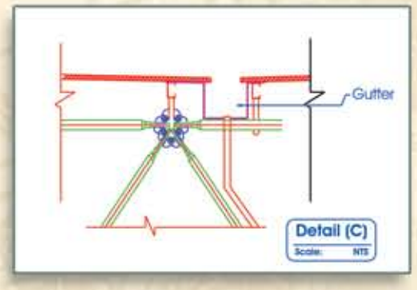


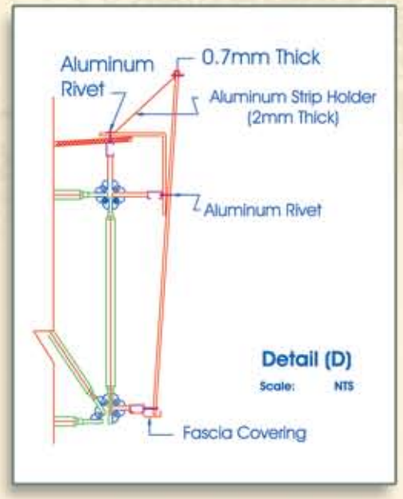


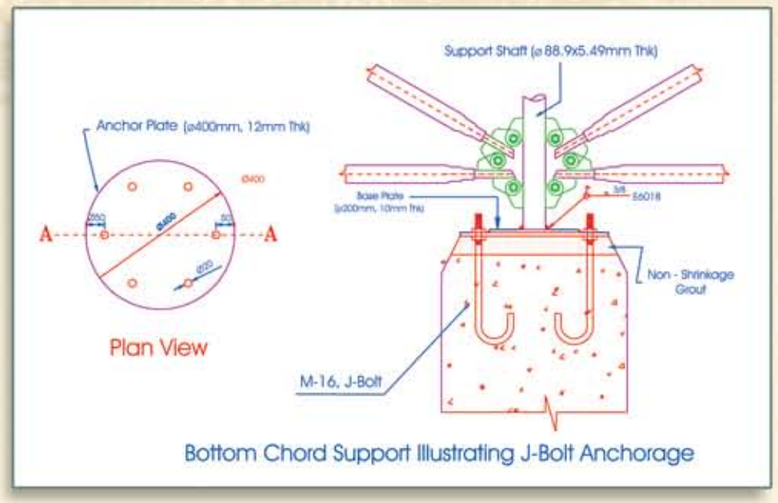
Typical Anchorage Details for Curved Entrance Canopy



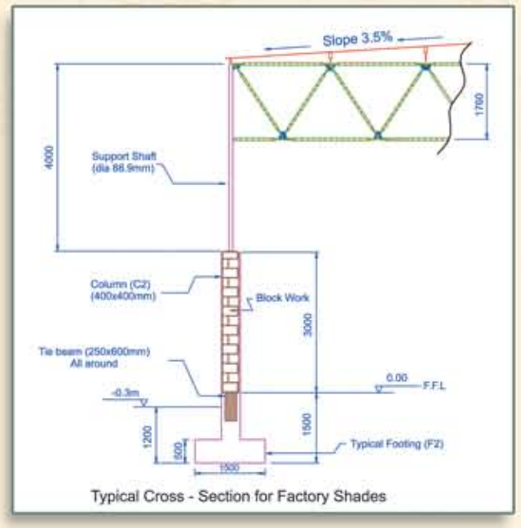




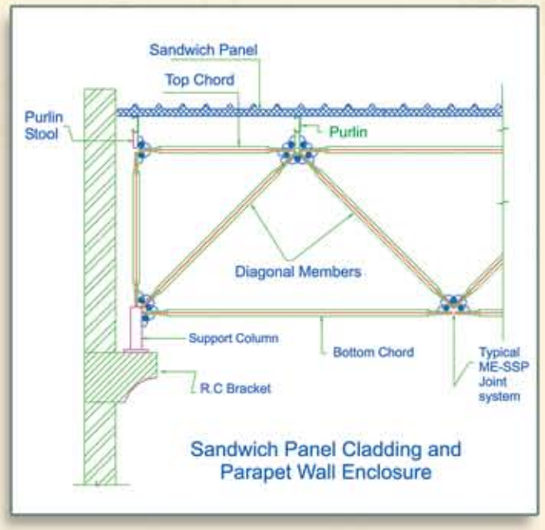




Bottom Chord Support Illustrating J-Bolt Anchorage

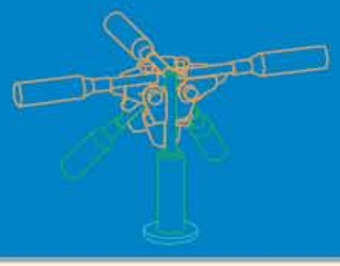


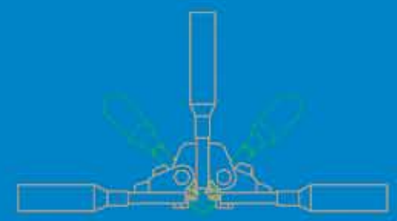
Typical Cross - Section for Factory Shades

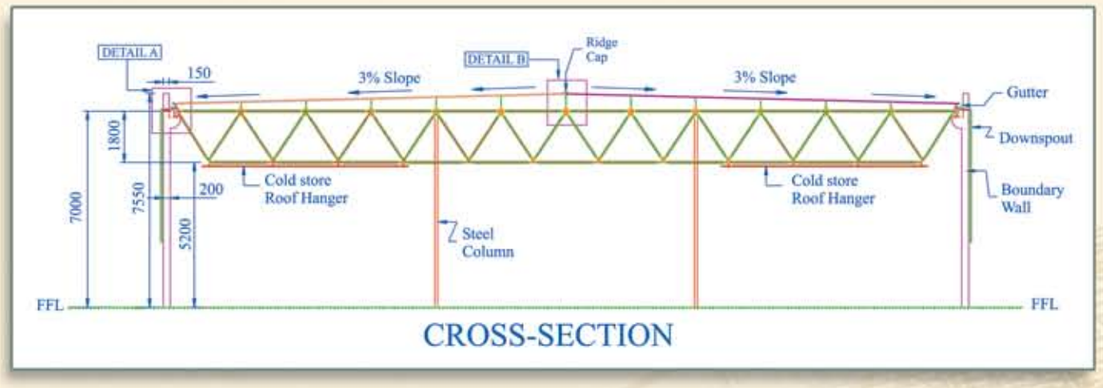


Sandwich Panel Cladding and Parapet Wall Enclosure

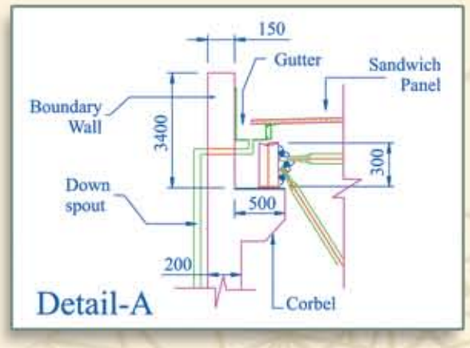
Sketches of Standard Attachments and Accessories



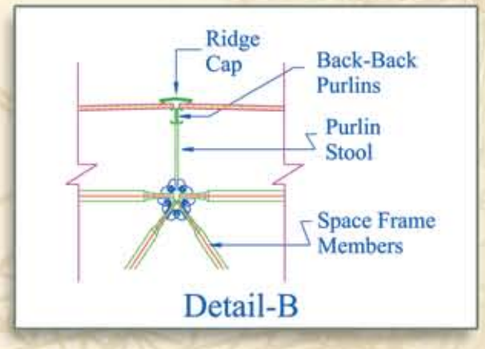




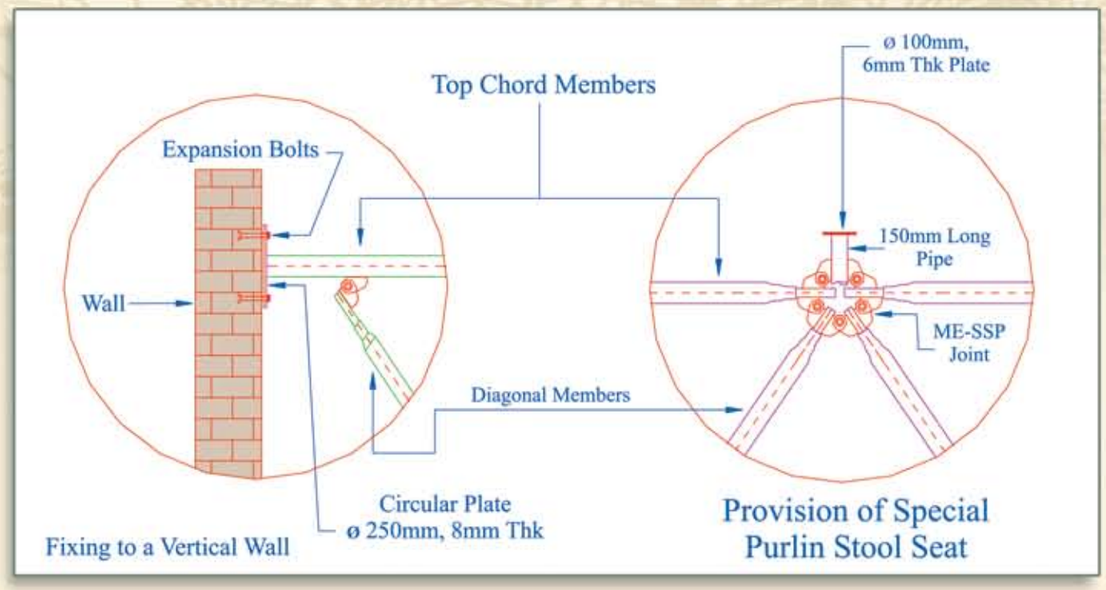
CROSS-SECTION

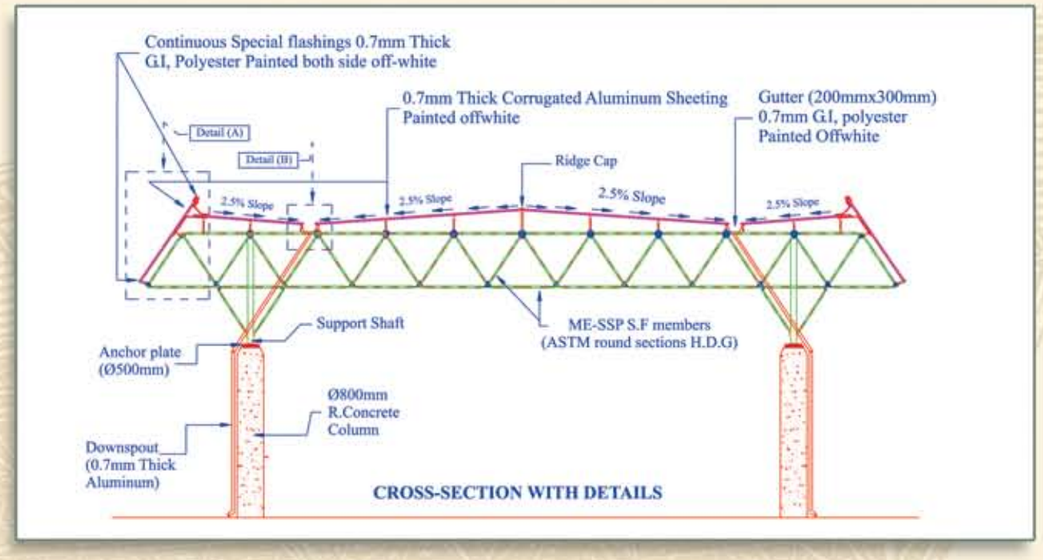


Detail-A

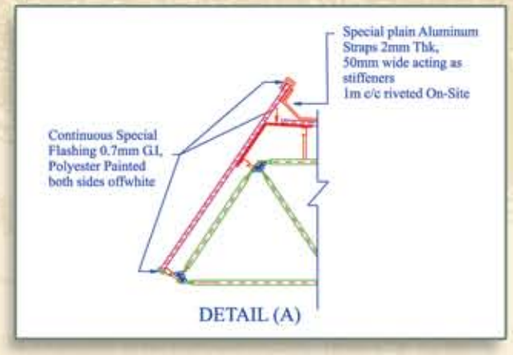


Detail-B

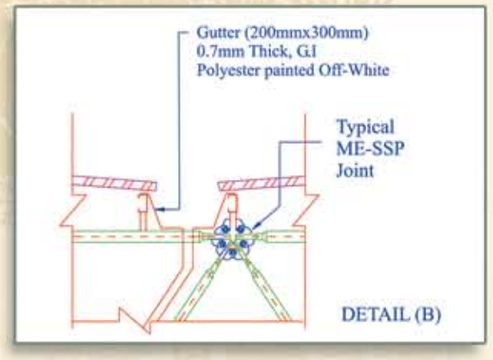




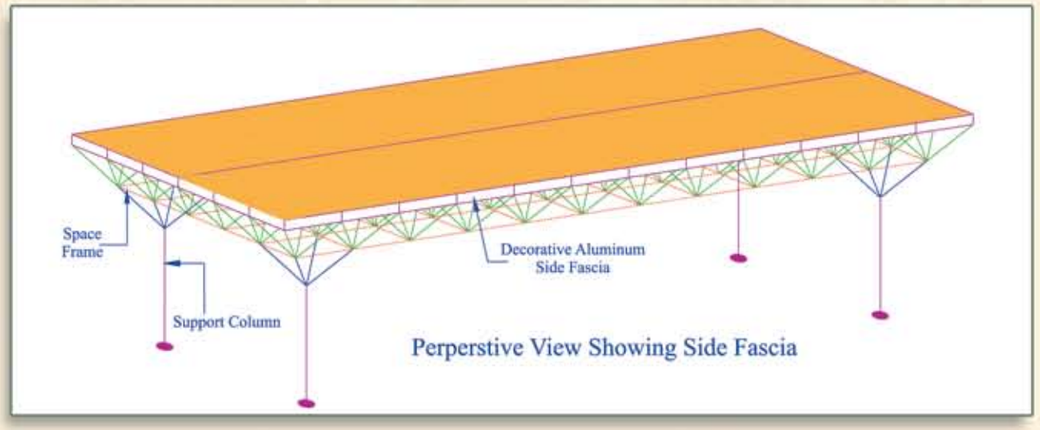
CROSS-SECTION WITH DETAILS



DETAIL (A)

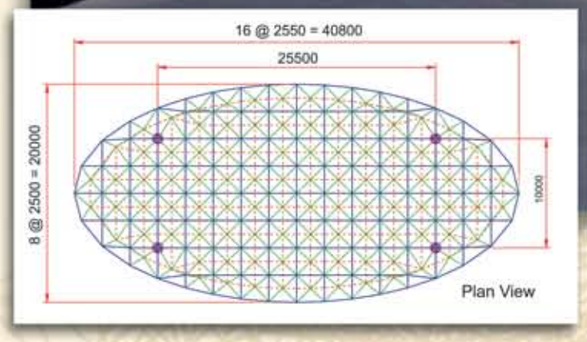


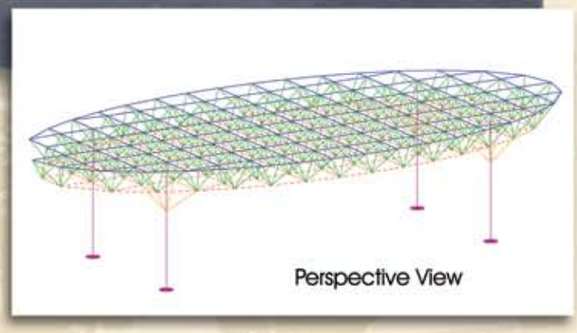
DETAIL (B)

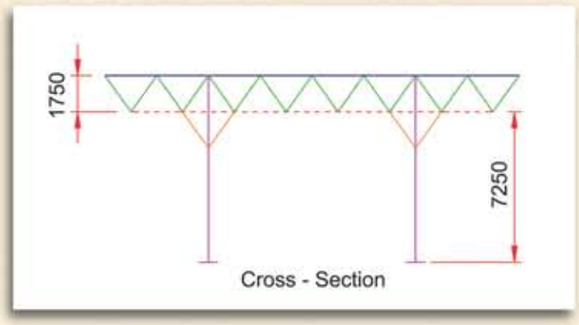


Perperstive View Showing Side Fascia

Khafji Joint Operations







The Khafji Joint Operations (KJO), ordered two elliptical sunshade canopies to cover two security entrances to the KJO area of operation. The flexibility of the **ME-SSP®** system allows the achievement of novel geometric shapes, as well as some of the most irregular geometries. The result was a very pleasant entrance canopies that combine function and aesthetics.

One added advantage that is particular to the **ME-SSP®** system, is the ability to traverse the columns from their base plates through the drop-down members joint onto the upper chord joint lying directly over that column. This results in a column section that can resist lateral forces in a three points bending, unlike other system which depend on the cantilevering action of columns to resist lateral forces. The result is a much sleeker column section, a far more efficient way of resisting lateral forces in canopies.