Appendix to Chapter 3

Transfer structures

Transfer structures take load where they can conveniently be collected and transfer them to where than can conveniently be resisted.
Sucha as:

1- Plain beams (Fig. 3.1a)
2- Triangulated frame (Fig. 3.1b)
3- Vierendeel frames (have panels and will be thick and heavy but can still look attractive) (Fig. 3.1c)
4- Arches (lighter than frames) (Fig. 3.1d)
5- Catenaries (Fig. 3.1d)

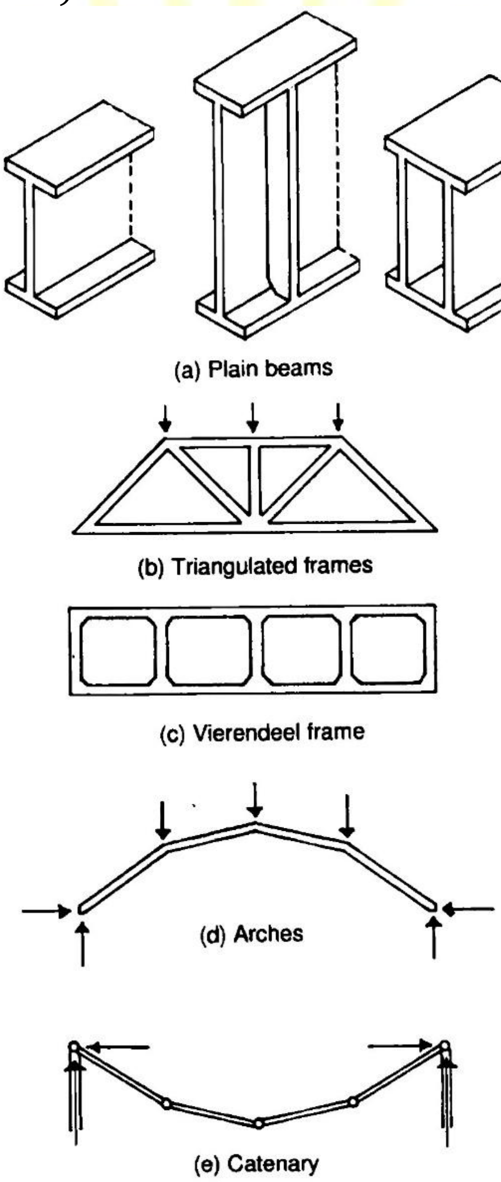


Fig. 3-1 transfer structures


Vierendeel: Girder and Fram

Tension members

In a single bay structure, the effects of patch loading (uneven, and hence unbalanced, distribution of load) will not cause a fundamental problem because the load path is the same as that which carries uniform load (Fig. 3-2).

However, if the structure is multi-bay or spine, patch loading may put the adjacent bay into uplift (Fig. 3-3).

A solution to this problem to prevent the columns from deflecting enough to cause significant loss of support to the loaded span. There are three ways of achieving this: by

1- Making the column structure stiff enough itself (Fig. 3-4).
2- Guying the column directly (Fig. 3-5).
3- Devising a system that is efficient at resisting uplift and does not cause loss of column restraint (Fig. 3-6). The latter also solves the problem of wind uplift. In practice, designs may incorporate elements of more than one of these principles (Fig. 3-7).

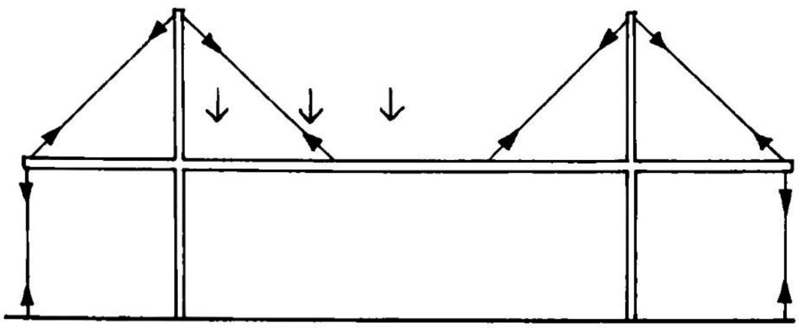


Fig. 3-2 Patch loading on tension structures

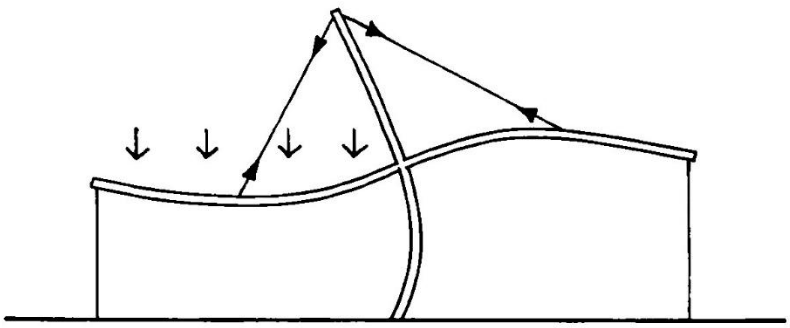


Fig. 3-3 Uneven loading causing uplift

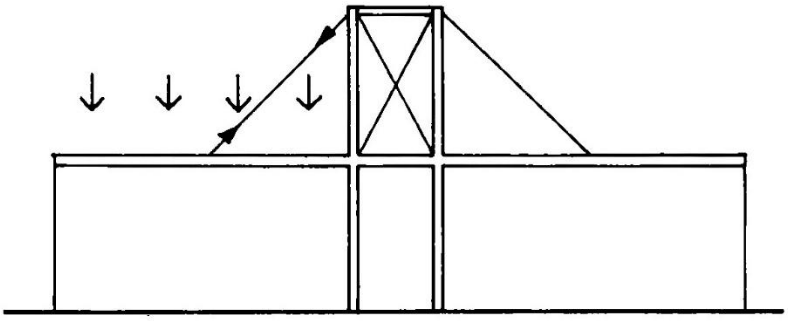


Fig. 3-4 stiff columns resisting the effect of unbalancing loading

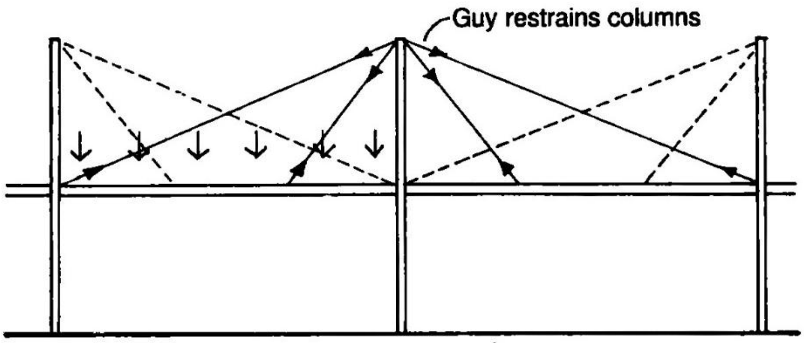


Fig. 3-5 Use of guys to restrain columns

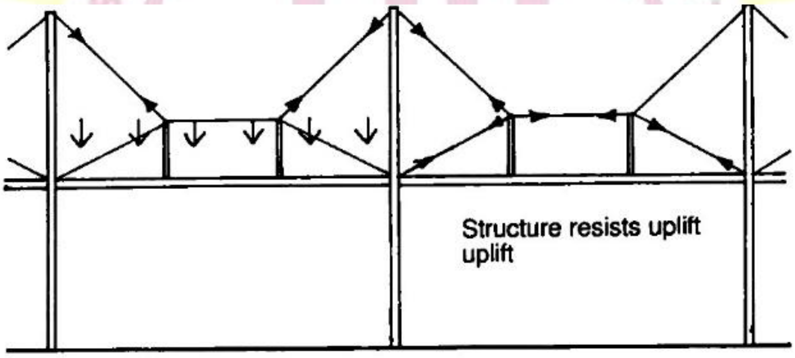


Fig. 3-6 system efficient at resisting uplift

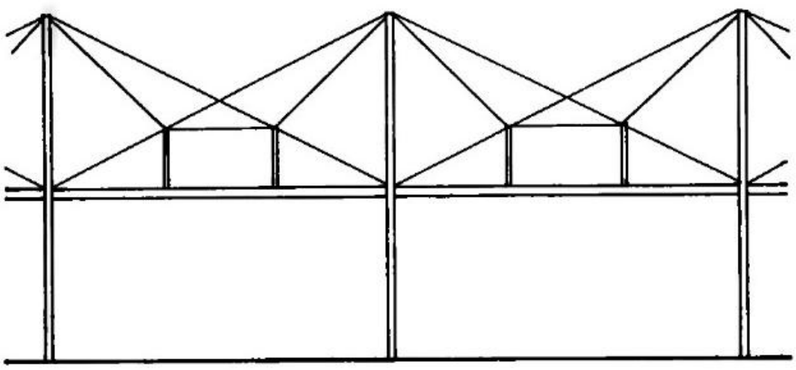


Fig. 3-7 combined systems to deal with unbalanced loading

Wind Uplift

The wind in some areas can be sufficiently strong that the resultant uplift on a lightweight roof can be almost as great as the self-weight.
Conventional roof has the potential of equal strength against upwards and downwards load, a tension roof designed against downwards load may have very little strength against upwards load (Fig. 20.22). Wind uplift therefore needs to be considered as a primary design case. Solutions are:

1- ensure that the beams will span between the columns under uplift.
2- arrange the tension structure so that it carries both upwards and downwards loads (Fig. 20.23).

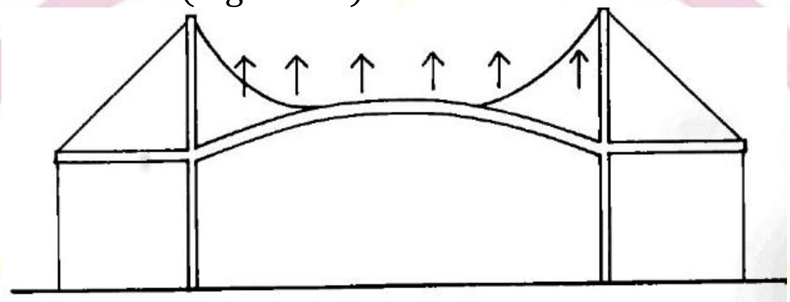


Fig.3-8 The effect of wind uplift

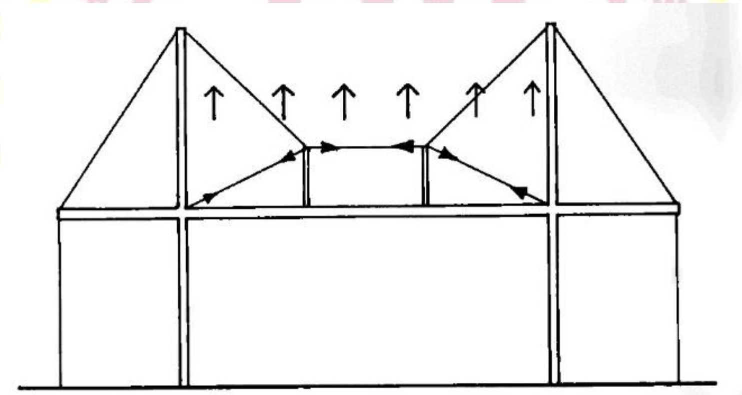


Fig. 3-9 Tension structures to resist both uplift and downward loads

Steel joists

1- Wide-Flange Section

The support system for this exterior walkway has been fabricated from wide-flange sections. Connections have used a combination of welding and bolting

The connection detailing of the National Works Yard demonstrates the combined use of welded and bolted connections. The bolted connections are used to assist in on-site erection and are made visible as a part of the design detailing by expressing the bolts themselves. They give the structure a more technical feel that suits the function of the building.

Wide-flange (Universal) members have been selected to create this exposed steel truss at the Gaylord Conference Center in Dallas, TX, USA. The member-to-member connections that form the transfer nodes of the truss are using simple bolted gusset plates.

The technical or industrial appearance of wide-flange (Universal) sections is a good match to galvanizing as a final and corrosion coating, as has been done in the Calgary Water Building in Calgary, AB, Canada. This project makes predominant use of shop-welded connections within the truss, while bolted connections are used between larger elements to simplify the erection process.

2- TUBULAR OR HOLLOW STRUCTURAL SECTIONS(HSS)

(left) The Humber River Bridge in Toronto, ON, Canada, uses large-diameter, helically welded tubes for the main spanning sections of the arch. (b) Close view of the bridge arch shows the helical weld.

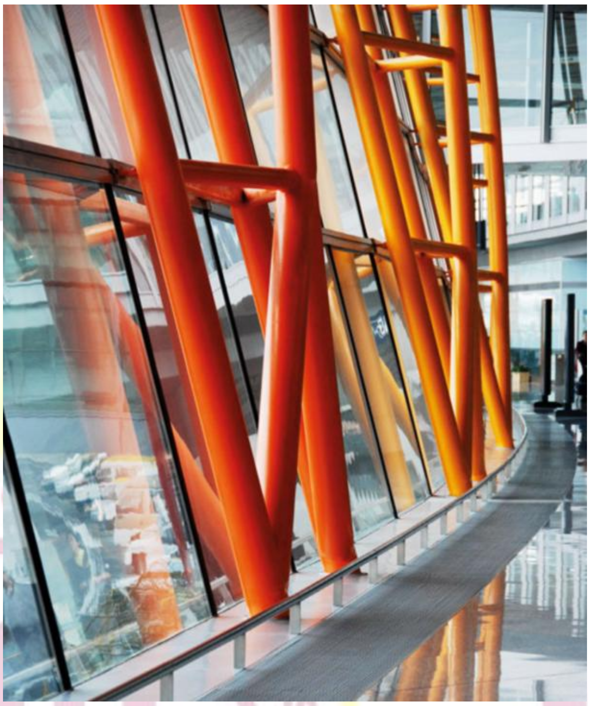
Capital Gate Abu Dhabi

The texture of the tubular frame structure that supports the massive sun-shading device on Capital Gate in Abu Dhabi, UAE, has a more technical feel due to the use of bolted connections that rely on the insertion of a welded plate into the section

The trusses that provide wind bracing and lateral support for the large glazed façades at the Beijing Capital International Airport in Beijing, China.

The choice of welded connections within the trusses provides a very smooth appearance.

The tubes that form the exterior members of the truss are larger in diameter than the cross members, making the welding of the smaller element to the larger one easier to fit.

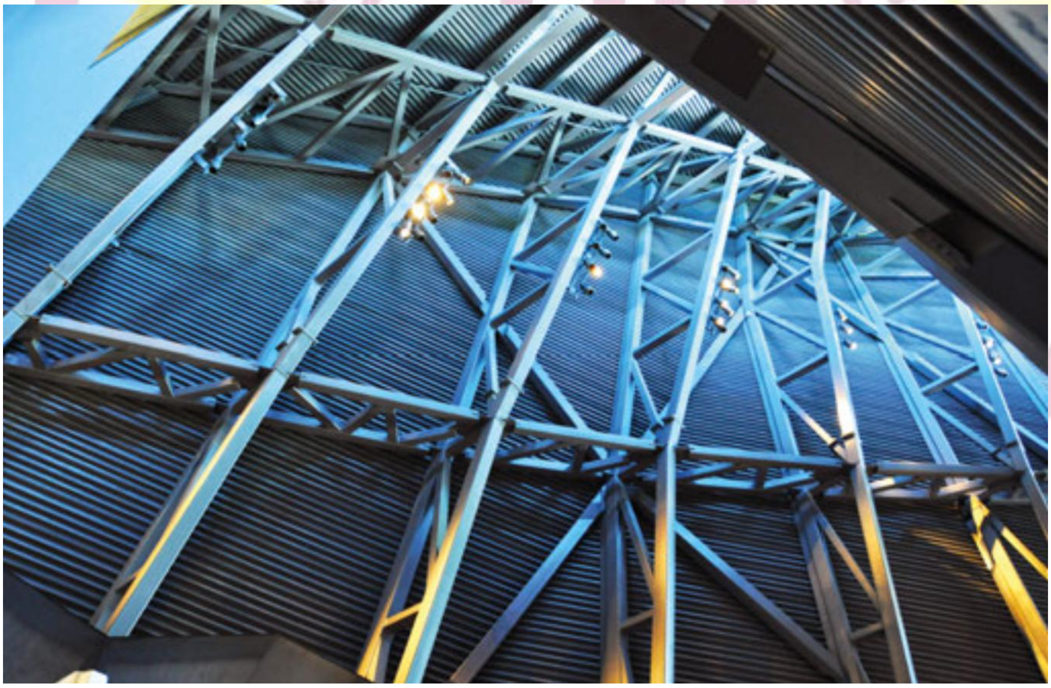


The addition to King's Cross Station in London, England.

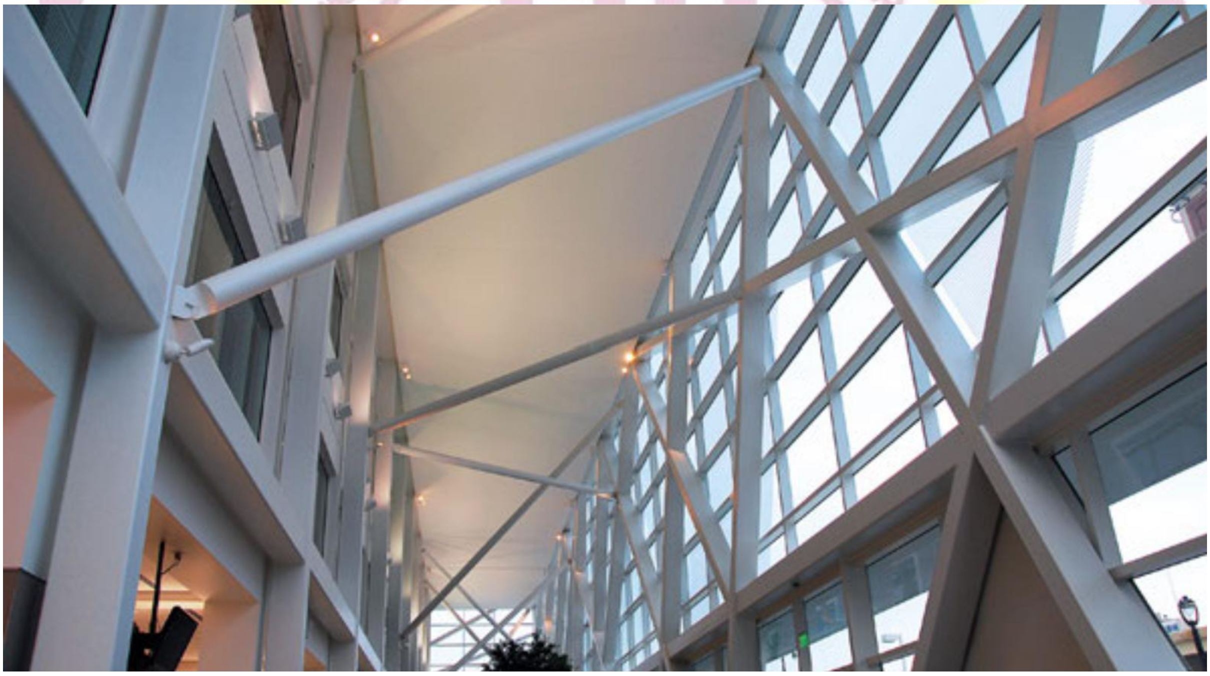
Makes predominant use of round tubular material to create this dynamic diagrid-like structure.

Round tubes were selected for their ease of use in situations requiring curvature of the structure.

3- Square or Rectangular Hollow Structural Sections



The square HSS of the Canadian War Museum in Ottawa, ON, Canada, designed by Raymond Moriyama Architect, were designed to provide the aesthetic of a war-torn landscape. The erratic twist to the shape of the space is complemented by an expressive sequence of bolted connections between the members, while the internal connections of the trusses are fully shop-welded



Wisconsin Intermodal Terminal in Milwaukee, WI, USA.

The structural system uses square and rectangular HSS with fully welded connections (top photo).

The choice of round HSS for the bracing that crosses over the passenger waiting area (bottom photo) alters the feeling and texture of the space. The simple pin connections at the ends of the tubular braces contrast with the fully welded connections between the rectangular sections.