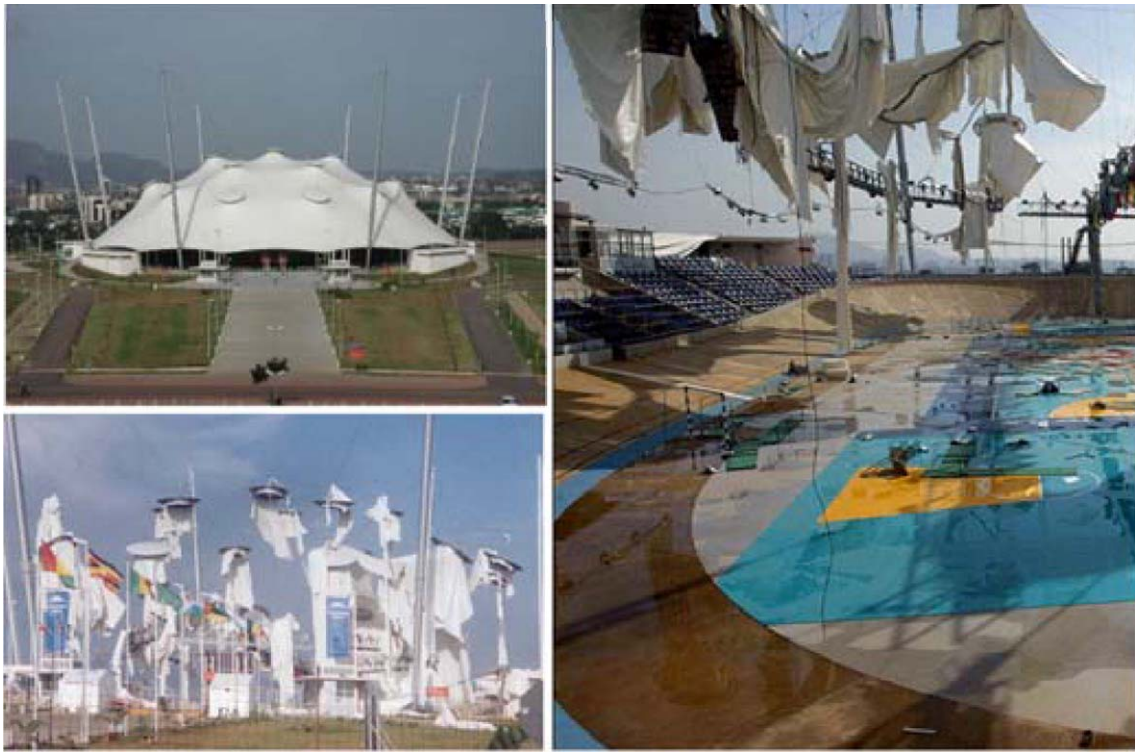
STABILITY AND REDUNDANCY

Design has to be such that in the event of the failure of one or more membrane fields within a roof, the whole system does not collapse, and heavy elements such as masts are arrested by a fail-safe system.



The membrane is torn but the masts are arrested by cables

Damage should not be disproportionate to its cause and security elements may need to be added into the structure's system. Often they consist of cables that connect the main supporting points, e.g. mast heads. Such elements may not have an active function day-today, but serve to avoid big displacements of the overall structure in the case of loss of a membrane panel or the collapse of a support. The membrane itself does not represent quite the same degree of danger in such a situation because of its low self-weight. As a further security measure, fail-safe cables can be arranged to run inside pockets welded to the membrane without influencing the flow of forces through the membrane (European Design Guide, 2004).

The stability of the whole structure depends on the integrity of each component. A local failure can easily cause a general collapse. Complementary cables are recommended to increase the safety at critical points, such as top masts, whose failure may cause great damage or personal injuries.

The "Giant of the Seven Seas" was a theatrical design for the 2004 Barcelona Forum of Cultures. It included a trapeze frame to receive the tackles of the artists and a velum to protect the performers from direct sunlight at noon. The trapeze frame was a large stayed self-supporting structure of 55 m x 25 m with struts of 21 m of height. It presented a complex geometry in space, all the posts were oblique and different. The velum, of a surface of 230 m^2, was a perforated fabric with low anticlastic curvature in certain zones accepted because accumulation of water was not possible, displacements were checked carefully and durability was guaranteed by the manufacturer.

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However it did not survive the first storm. The membrane began to flutter and continued to flap until it tore. This was due to additional oblique cables added to the initial design. Their contacts with the membrane during its displacements under the strong wind (100 km/h speed), inevitably tore it causing its ruin (TensiNews 8, 9). Fortunately the stability of the whole structure was not dependant on the integrity of the membrane, so its failure did not cause a general collapse.

Llorens & Soldevila, Architects, 1981: FASA–Renault Sport Facilities, Valladolid.

For the FASA–Renault Sport Facilities in Valladolid, protection of the dining area from the sun was needed. **1** A surface of revolution around a central mast was designed varying the radius in plan to preserve the pine forest. Both the size and the shape make it clearly noticeable from any point of the sports and rest facilities. **2** The top is open to act as ventilation chimney. **3** To reduce heat transmission, opaque (non-translucent) fabric was used. The seams disappear because they are not seen against the light. The reading of the spatiality is not so immediate. The lightness is not perceived from the interior and the quality of the diffuse lighting is affected. **4** Notice the three redundant complementary cables that increase the safety holding the mast in the event that the membrane is torn.