SOME EXAMPLES OF MOBILE ROOF STRUCTURES

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Abstract
The present paper is addressed to the illustration of the conceptual design definition of two mobile roof structures, corresponding to:

- Existing open-air swimming pool in Bologna and Rome.
- Retractable roof of Ohita and Venice Stadium
- The temporary coverings for the 2015 EXPO in Milan

1 The swimming pool of Bologna and Rome

The open air facility in Bologna, named Carmen Longo, was built in 1929 and the existing brickwork construction is protected under the ethic and esthetic control of the Superintendence of cultural and environmental values . The variation of state produced by the new roof on the existing context was checked by a CAD 3D rendering showing the materials and the real dimensions of the structural elements.
The conceptual architectural and structural design of the roof was based principally on the following hypothesis and constraints:

- minimization of the external dimensions of the roof;
- formal , historical and typological compatibility of the roof structures;
- architectonical compatibility between roof material and brickwork;
- partial convertibility of the roof;
- natural lighting and solar energy contribution from the south-east area of the covering.

The covering has been realized partly fixed and partly movable by a sliding mechanism.
The fixed part adopts cooper sheets and the mobile part is in structural glass.
The main supporting structure has been realized in tubular steel profiles and is central longitudinally oriented.

Another example of mobile roof for a swimming pool is a retractable roof in Rome realized with a sliding system that is opened by horizontally moving/overlapping roof elements.

2 The retractable roof of Ohita and Venice Stadium

The new stadium of the city of Venice will be covered by a long span mobile roof structure mainly formed by:

- Two longitudinally oriented long span arches;
- Two lateral fixed shelters;
- Central roof covering made with fixed and mobile panels;

The two longitudinal arches, separated symmetrically by 90m, have a free span of 245m and a sag of 50m and they are made by steel profiles, centrally reinforced by prestressed steel cables. The geometrical configuration in the plane of the arches is circular, in order to provide an overlapping parallel moving system .
The lateral fixed roof coverings are made by a transversal oriented steel girders. The fixed roof parts have also the task of stabilizing, out of plane, the main structure.
The mobile panels have a cylindrical shape with a surface dimension of 60x90m. The adopted driving mechanism is the cable traction method.

The roof covering of the mobile and fixed parts of the stadium is a prestressed membrane of fiber reinforced coated by PTFE.

Unlike the conventional movement systems used for converting large sports areas, the Ohita roofing has been designed to have multi-purpose uses; as football stadiums are essentially “open” and rarely used closed (only in cases of bad weather conditions) the design foresees the use of the roofing also in an “open” position for social and exhibition events.
The main structures are made of two 300 meters long arches positioned over the rectilinear stands. The fixed part of the roofing is obtained by using transversal beams, placed between the arches and the structures of the stands.
The middle area, which can be opened, has a span of about 110 meters and is made of spatial beams , covered by PTFE membrane.
The movement system is rack and pinion and has appropriate locking devices.

3 The temporary coverings for the 2015 EXPO in Milan
The preliminary design has been developed considering the following key design assumptions:

- an exhaustive research of the characteristics and physico-chemical properties of the membrane materials in order to satisfy the formal and artistic requirements of the project;
- the adoption of a temporary cover system that is fully recoverable and reusable;
- possibility of the realization of a typical real scale module in agreement with Eurocodice 1 (Design assisted by Testing - chapter 5).