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Dynamic response of low profile container crane under wind excitation

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Abstract

In general, several external actions must be considered for design the lifting equipment; some of these are: the weight of the component, the pay load and its dynamic actions, the actions induced by the earthquake, the load produced by the snow and wind.
In particular, concerning the action induced by the wind, the problem is studied and dealt by standards considering an equivalent static load applied to the structure. This action, essentially a force, depends on the wind speed, so on the specific pressure, the frontal area on which it acts and a aerodynamic coefficient which depends on the shape of the component.
The structures that constitute the lifting equipment also for economic considerations, are increasingly slender and tall and thus their first natural frequencies values are very low. For example, in the container crane these values below to 5 Hz.
This phenomenon is not present, for example, in civil structures because they have a much higher stiffness with respect to the steel structures used for lifting equipment.
Based on these preliminary considerations the wind interaction with the structures is becoming increasingly important in order to properly determine the actions that are generated on it.
The problem was studied by several points. The first concerns the theoretical evaluation of the actions induced on structures the by the wind; after that, the procedure was applied on a very height chimney (100 m).
In this step it was investigated how the calculation methods adopted for the numerical study of the structure (essentially the FEM model and the method implemented to resolve the equations) affect the numerical results obtained, mainly on the maximum displacements and therefore on the stress values present in the chimney.
It is important to underline that the numerical method used for resolve the equations is strongly dependent also on the material used for build the chimney. In fact, if the chimney is built with steel material instead of the reinforced concrete material, the structure is much more locally deformable. This consideration has an impact on the fact that, for example, the integration step of the equations must be much lower than the one used for the study of a chimney made of reinforced concrete.
Defined properly the correct procedure calculation, the study was carried out to a low profile crane subjected to wind actions. The main dimensions of the crane are: height=35 m and boom length=80 m.
The results show some considerations reported in the next points:

- the dynamic study of the wind action allows to simulate the time variable actions (displacements and stresses) and then to determine the real effect that these actions have on the structure, such as the fatigue damage;
- if the wind actions were considered like a static equivalent action (estimated by the standards), in some cases it underestimates the real magnitude of the action induced by the wind.

Keywords: Wind actions, dynamic loading, interaction wind - structure.

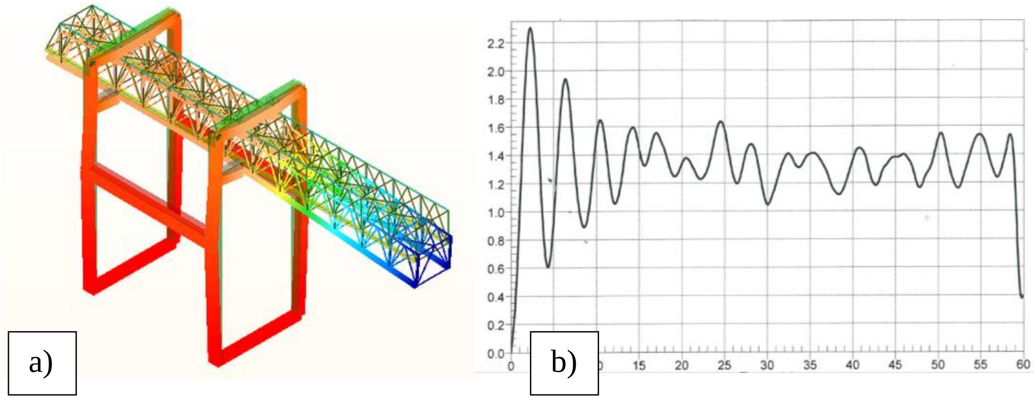

Fig. 1. a) Maximum displacement in the crane; b) time –varying displacement at the end of the boom.

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