Damage evaluation index of long-span spatial grid structure

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Abstract

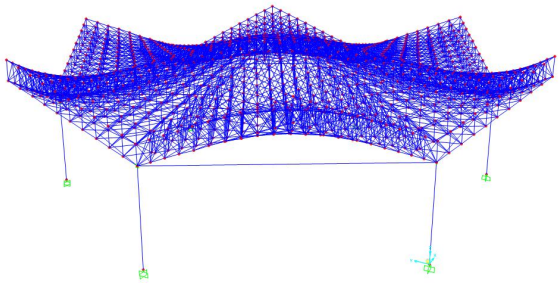
At present, there is little research on the evaluation index of the damage of long-span spatial grid structures under unexpected loads. This paper evaluates the damage of structures based on the double index of energy and displacement. Energy reflects the overall failure of the structure, but can not give the specific form of structural failure; Deformation is another important indicator of the degree of structural failure, it reflects the maximum displacement response of the structure, but it can not reflect the plastic cumulative energy dissipation of the structure. Therefore, the dynamic damage index D is put forward by combining the energy and displacement, which can more accurately reflect the degree of structural damage. The calculation of the dynamic damage index D is as shown in the formula (1).

$$D = \frac{\delta_m}{\delta_u} + \frac{\beta}{E_u}\int dE \qquad (1)$$

Where δ_m is the maximum displacement response of the structure under unexpected loads; δ_u is the ultimate displacement of the structure under static load; β is the coefficient of the structural system, usually taken as 1.0; $\int dE$ is the plastic cumulative energy dissipation of the structure under unexpected loads. E_u is the ultimate energy dissipation. The first term on the right side of equation (1) is the ratio of the maximum displacement response of the structure to the ultimate displacement of the structure under static load, reflecting the development of the ductile displacement of the structure. The second term on the right side of equation (1) reflects the ratio of plastic cumulative energy dissipation to ultimate energy dissipation, reflecting the development of structural plastic cumulative energy dissipation.

The degree of structural damage is divided by the dynamic damage index D. When $0 \le D < 0.3$, the structure is basically undamaged; when $0.3 \le D < 0.4$, the structure is slightly damaged; when $0.4 \le D < 2.0$, the structure is moderately damaged; when $2.0 \le D$, the structure is seriously damaged or collapsed.

The research object of this paper is long-span prestressed double-layer composite torsional reticulated shell, As shown in Figure (1). By removing the key components and prestressing cables in the structure and calculating the dynamic damage index D by formula (1), the damage situation of the structure can be judged. The dynamic damage index D studied in this paper can quantify the damage degree of the structure, which is more conducive to the damage study of long-span spatial structures.



Figure(1) long-span prestressed double-layer composite torsional reticulated shell