

Study on the ultimate load with catastrophe models

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The ultimate load determination of structures is an important content of structure ultimate failure analysis and its safety degree determination. In this paper, catastrophe theory is used to evaluate the ultimate load of concrete gravity dam, and different catastrophe models on the ultimate load predictions are discussed for the ultimate failure of gravity dam along the base surface. In the analytical model, both the dam and the foundation are assumed as rigid bodies, and the base surface of the dam is considered sitting on a weak interface. With the horizontal displacement of the base surface regarded as a state variable and the applied upper water pressure as a control variable, the fold and cusp catastrophe models for the unstable failure of the above simple model are established, and the corresponding values of ultimate load are obtained. It shows that the result by the fold catastrophe model is consistent with the available theoretical value, while the one by the cusp catastrophe model is smaller. It also demonstrates that the fold catastrophe model is capable of determining the maximal ultimate load against the ultimate failure of gravity dam when the material constitutive relationship of failure surface is elastic-perfectly plastic or only the hardening stage is considered. And the cusp catastrophe model is suitable for obtaining the residual ultimate load when the material of failure surface involves to the softening stage.

Keywords: Ultimate load; fold catastrophe; cusp catastrophe; gravity dam