

Shakedown analysis of 3D frames subjected to complex statical and seismic load combinations

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ABSTRACT

Structures, during their operational life, are subjected to a sequence of variable actions, including dead, anthropic and natural loads. Building codes fix the range and extension of load variability through combination formulas that usually involve a large number of load conditions. The loading scenario can become very complex in presence of seismic actions taken into account through nonlinear modal combination rules such as the well known SRSS or CQC rules.

In this context shakedown analysis furnishes, in a direct way, a reliable safety factor against plastic collapse, loss in functionality due to excessive deformation (ratcheting) or collapse due to low cycle fatigue (plastic shakedown), and also provides valuable information about the internal stress redistribution due to the plastic adaptation phenomenon [1].

Despite its technical implications, nowadays shakedown analysis still seems confined to the research community instead of being a common tool in structural design. This is largely due to the difficulties in managing the large number of load conditions and the complex combination rules required by widely employed building codes which greatly increase the solution costs and prevent analysis.

In the paper, with respect to 3D frames, a strategy for an efficient treatment of complex statical and seismic load combinations is proposed with the aim of making the shakedown analysis an affordable design tool to be used in practical applications. An algorithm capable of detecting a small number of significant elastic stresses within those corresponding to the load domain and suitable for use in the case of response spectrum analyses, is proposed.

The yield surface of the beam sections is defined by its support function values associated to pressoflexural mechanisms and it is approximated as Minkowski sum of ellipsoids. The analysis is performed on the basis of the algorithms proposed in [2,3]. A series of numerical tests are presented to show both the accuracy and the effectiveness of the strategy.

REFERENCES

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