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Reliability analysis of double-layer domes with stochastic geometric imperfections

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Abstract. This study aimed to investigate the effect of initial member length an imperfection in the load carrying capacity of double-layer domes space structures. First, for the member length imperfection of each member, a random number is generated from a normal distribution. Thereupon, the amount of the imperfection randomly varies from one member to another. Afterwards, based on the Push Down analysis, the collapse behavior and the ultimate capacity of the considered structure is determined using nonlinear analysis performed by the OpenSees software and this procedure is repeated numerous times by Monte Carlo simulation method. Finally, the reliability of structures is determined. The results show that the collapse behavior of double-layer domes space structures is highly sensitive to the random distribution of initial imperfections.

Keywords: reliability; Monte Carlo simulation method; progressive collapse; imperfection; double layer grids; space structures; domes

1. Introduction

In the recent decades, the use of space structures to cover large spans with no internal columns has become increasingly prevalent due to advantages such as low weight and considerable stiffness. These structures are regularly built by connecting steel rods in single or double layer forms (Thornton and Lew 1984). The factors that affect the behavior of these structures are quite diverse and depend upon the behavior of every single member and also their connecting system. Although these structures are manufactured industrially, the members of these structures behave inconsistently because of different mechanical and geometrical properties. Carried out studies on double-layer grids have shown that these types of structures have a symmetrical behavior in the elastic state but display an asymmetrical behavior in the inelastic state and this is due to the existence of common imperfections in the structure.

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