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EFFECT OF A FUNCTIONALLY GRADED MATERIAL INCLUSION ON THE STRESS CONCENTRATION IN THIN PLATES AND CYLINDRICAL SHELLS WITH A CIRCULAR OPENING

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Due to a combination of a significant strength and a relatively low weight, thin-walled structures have found wide application in various branches of technology, in particular, space-rocket engineering, oil-and-gas engineering, power engineering, construction, etc. The presence of openings in their plate and shell components leads to a sharp increase in local stresses, which, under certain conditions, may trigger destructive processes. The use of functionally graded materials (FGMs) with certain mechanical properties can significantly reduce the stress concentration in the vicinity of local concentrators in the form of openings, cutouts, fillets, grooves, etc.

This paper presents the results of computer simulation and finite element analysis of the stress and strain fields of thin plates and thin-walled cylindrical shells with a circular opening and an annular FGM inclusion surrounding it. The effect of the dimensions of the FGM inclusion and the law of variation of its elastic modulus on the stress and strain concentration in the vicinity of the opening was studied. The stress and strain intensity distribution in local stress concentration zones was obtained. It was found that an annular FGM inclusion with certain mechanical properties can reduce the stress concentration factor by more than 30%. In this case, a proportional decrease in strain intensity in the vicinity of the opening is also observed. The law of variation of the elastic modulus of the FGM inclusion and the inclusion width have a significant effect not only on the level of stress and strain concentration, but also on the stress and strain pattern. The results of the large-scale computational experiments show that an FGM annular inclusion reduces both the stress and the strain intensity around the opening.

Therefore, the use of annular FGM reinforcements in plates and cylindrical shells with openings makes it possible to control the distribution and magnitude of the stress and strain intensities in local stress and strain concentration zones.

Keywords: *elastic plate, thin-walled cylindrical shell, circular opening, annular inclusion, functionally graded material, stress and strain field, stress concentration factor, finite-element analysis.*

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