COLLAPSE OF DOUBLE-LAYER SPACE GRID STRUCTURES

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Abstract

This dissertation is concerned with the behaviour of square-on-square double-layer space grids (DLSG's) and in particular their collapse mechanisms after initial buckling.

A detailed review of the methods used for collapse analysis of these structures is conducted, which shows, that their collapse can be of progressive nature. An outline of the remedies that have been suggested to make safe their collapse behaviour is given, and it traces the line for further study. The present investigation starts by describing the redundancy in these regular pin-jointed assemblies in terms of unit states of self stress. This enables us to understand, by means of the extended Maxwell rule, how it is that mechanisms of collapse can occur when relatively few bars in the assembly have failed. The influence of boundary conditions on the mechanisms of collapse and its progressive nature is also investigated. This method of analysis is verified by detailed examination of several previously reported experimental results, and some conclusions can be drawn.

The pre-stressing of statically indeterminate assemblies by means of lack-of-fit is investigated in the hope of changing their collapse characteristics. The unit stat of self-stress has been used to explain a method of selecting the bars that can be short-ended/lengthened in order to impose a prescribed state of self-stress, and the scope for achievable patterns of bar tensions has been described. A by-product of the investigation is an algorithm which calculates the required lack-of-fit to impose an initial state if self stress which maximises the load-carrying capacity of indeterminate trusses. Using the formulae derived for pre-stress, a statistical analysis is developed to estimate initial bar tensions due to random lack-of-fit in order to obtain realistic estimate of the load-factor of an assembly before initial failure. Furthermore, we have argued and demonstrated how backlash at the bar-joint connection may

have a beneficial effect in reducing substantially initial bar tensions due to the inevitable lack-of-fit on account of manufacturing errors of bars.

An extensive experimental program has been conducted to verify the assumptions adopted and formulae derived in this dissertation.