Graph products with specified domains for configuration processing and formation of the adjacency matrices

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Abstract

Purpose – Recently graph products are extensively used in the analysis and design of regular structures. It is often thought that these products are only applicable to regular graphs. The main aim of this paper is develop new products which are applicable to regular as well and non-regular structural models.

Methodology/approach – In this paper new graph products are defined with specified domains. In these products the logical operations of the graph products are only performable in specified domains, and therefore these products can produce configurations which do not need to be regular.

Findings – New graph products are defined and a general theorem is proved for the formation of their adjacency matrices.

Originality/value – The presented graph products overcome the difficulty of employing graph products in structural mechanics, and in particular in space structures. The general theorem of this paper can efficiently be used in the formation of adjacency matrices of the structural models.

Keywords: Graph products with specified domains, configuration processing, Non-complete extended p-sum (NEPS), adjacency matrices, space structures.

Paper type: Research paper

1. Introduction

For large systems, configuration processing is one of the most tedious and time-consuming parts of the analysis. Different methods have been proposed for configuration processing and data generation, among which the formex algebra of Nooshin (1975,1984) is a commonly used tool for this purpose (see also Nooshin et al. (1993) Nooshin & Disney (2000,2002). Behravesh et al. (1988) employed set theory and showed that some concepts of set algebra can be used to build up a general method for describing the interconnection patterns of structural systems. Graph theoretical methods for the formation of structural and finite element models are developed by Kaveh (1993,2004). In all these methods a submodel is expressed in algebraic forms and then functions are used for the formation of the entire model. The main functions employed consist of translation, rotation, reflection and projection, or combination of these functions.

On the other hand many structural models can be viewed as the graph products of two or three subgraphs, known as their *generators*. Many properties of structural models can be obtained by considering the properties of their generators. This simplifies many complicated calculations, particularly in relation with eigensolution of regular structures, as shown by Kaveh and Rahami (2005,2006). Configuration processing using graph products is developed by Kaveh