Weighted Graph Products for Configuration Processing of Planar and Space Structures

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(Received 26/02/08 - Revised version 04/11/08 Acceptation 06/01/09)

ABSTRACT: In this paper three graph products and three weighted graph products are presented for the formation of structural models. The graph products are extensively used in graph theory and combinatorial optimization, however, the weighted products defined in this paper are more suitable for the formation of practical structural models. Here, the simple and weighted products are employed for the configuration processing of space structures. This application can easily be extended to the formation of finite element models.

Key Words: Weighted graph products, Configuration processing, Generators, Space structures, Grids.

1. INTRODUCTION

For a large system, 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 [1,2] is the most general tool for this purpose (see also Nooshin et al. [3] Nooshin & Disney [4]). Behravesh et al. [5] 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 [6,7]. In all these methods a submodel is expressed in algebraic forms and the 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. Four undirected graph products and four directed graph products are employed for the formation of structural models by Kaveh and Koohestani [8]. There are many other references on the field of data generation; however, most of them are prepared for specific classes of problem. For example, many algorithms have been developed and successfully implemented on mesh or grid generation, a complete review of which may be found in a paper by Thacker [9] and in books by Thomson et al. [10], Liseikin [11] and Topping et al. [12].

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 [13,14].

In this paper, weights are assigned to nodes and members of the generators to generate configurations which can not be formed using the four existing graph products [15]. The new products are especially suitable for the formation of the

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