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Application of Spatial Structures in Bridge Deck

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Abstract

Spatial structure is a truss-like, lightweight and rigid structure with a regular geometric form. Usually from these structures is used in covering of long-span roofs. But these structures due to the lightness, ease and expedite of implementation are a suitable replacement for bridge deck. However steel and concrete is commonly used to build bridge deck, but heavy weight of steel and concrete decks and impossibility of making them as long-span bridge deck is caused engineers to thinks about new material that besides lightness and ease of implementation, provide an acceptable resistance against applied loads including both dead load and dynamic load caused by the passage of motor vehicles. Therefore, the purpose of this paper is design and analysis bridge deck that's made of double-layer spatial frames compared with steel and concrete deck. Then allowable deflections due to dead and live loads, weight of bridge in any model and also economic and environmental aspects of this idea is checked. As a result, it can be said that the use of spatial structures in bridge deck is lead to build bridge with long spans, reducing the material and consequently reducing the structural weight and economic savings. For geometric shape of the spatial structure bridge is used of Formian 2.0 software and for analysis of bridges is used of SAP2000 with finite element method (FEM).

Keywords: Spatial Structures, Bridge Deck, Steel and Concrete Deck, Finite Element Method, Deflection.

1. Introduction

In architecture and structural engineering, a spatial frame or spatial structure is a truss like, lightweight rigid structure constructed from interlocking struts in a geometric pattern. Spatial frames can be used to span large areas with few interior supports. Like the truss, a spatial frame is strong because of the inherent rigidity of the triangle, flexing loads are transmitted as tension and compression loads along the length of each strut. A spatial frame truss is a three-dimensional framework of members pinned at their ends. A tetrahedron shape is the simplest spatial truss, consisting of six members which meet at four joints. Large planar structures may be composed from tetrahedrons with common edges and they are also employed in the base structures of large free-standing power line pylons [1]. The simplest form of spatial frame is a horizontal slab of interlocking square pyramids and tetrahedron built from aluminum or tubular steel struts. Architects and engineers are always seeking new ways of solving the problem of spatial enclosure. With the industrialization and development of the modern world there is a demand for efficient and adaptable long-span structures. Spatial grid structures are a valuable tool for the architect or engineer in search for new forms, owing to their wide diversity and flexibility. Before entering into a discussion of the design and use of spatial grids in the late twentieth century, it is useful to look back at the early use of three-dimensional structures [2]. Until the middle of the eighteenth century the main construction materials available to architects and engineers were stone, wood and brick. Metals, being in relatively short supply, were used mainly for jointing of the other materials. Of the widely available materials, stone and brick are strong in compression but weak in tension. Thus they are suitable for three-dimensional structural forms such as domes and vaults. Impressive feats of vaulting were achieved by medieval masons but the largest span masonry domes, St Peter's Basilica in Rome (1588–93) and Santa Maria del Fiore in Florence (1420–34) are both approximately 42 m diameter at the base. Good quality timber has strength in tension and compression but is naturally available only in limited lengths and with limited cross-section [3]. For large-scale three-

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