

世博会工程专辑

世博文化中心钢屋盖结构设计

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摘要:

上海世博文化中心整体建筑呈飞碟形, 其屋盖为大跨度空间钢桁架结构, 屋盖立柱支承于下部结构斜框架的顶部。由于建筑功能的特殊要求, 屋盖悬挂大量附加荷载, 矢跨比较小, 屋盖结构设计综合考虑建筑造型、内部使用空间、下部结构受力以及施工安装等多方面的要求。对不同的屋盖结构体系进行比选, 综合建筑要求、结构受力和施工难度等因素确定采用空间桁架结构体系, 设置支承结构环梁和屋盖环向桁架可有效缓解屋盖的竖向变形; 比较风洞试验结果和欧洲规范计算结果, 对类似文化中心的扁平屋盖, 按欧洲规范确定的风荷载的分布规律和数值具有一定的参考价值; 屋盖结构与下部结构相互作用分析结果表明, 设计中应充分考虑下部结构对屋盖结构的影响; 为有效解决屋盖与下部结构受力的矛盾, 提出上下兼顾的设计方法, 即根据屋盖支座的约束条件将施工划分为两阶段: 第1阶段屋盖支座为滑动支座, 第2阶段屋盖与立柱为铰接; 同时基于屋盖刚度和减小对下部结构的推力, 采用施工顺序加载分析确定第1阶段屋盖上施加荷载的最大值和最小值。设计结果表明, 屋盖结构既能满足建筑外形要求、复杂的功能要求, 又具有结构受力合理、施工快速简便的特点。

关键词: 空间桁架结构 风荷载 上下结构相互作用 施工顺序分析

Structural design on steel roof of the World Expo Cultural Center

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Abstract:

The roof structure of the World Expo Cultural Center is a large span truss supported on the inclined frame underneath. Huge suspended load, unusual architectural outline, usable space inside, lower structure mechanics and construction as well should be considered in the structural design for the roof. Structural simplification was first conducted to solve the problem arising from special shape. After comparison of different roof system, considering roof shape, structural mechanics and construction convenience, space truss was finally selected. Ring beams in the support structure and ring trusses in the roof structure can reduce roof deformation effectively without increasing the horizontal reaction of columns. Wind load can be estimated according to Euro code for the flat structure, similar to the roof, based on the comparison between calculation result following Euro code and wind tunnel test. The analysis, considering the counteraction of roof structure and the lower structure indicates that the influence of lower structure on the inner force and deformation of roof is significant enough to be considered in the roof structural design. The construction is divided into two phases according to the boundary of roof, which is sliding in the first phase and hinge in the second. Considering the need of roof stiffness and decreasing the thrust on the lower structure, the maximum and minimum loads added in the first phase are calculated by construction sequence analysis. Design results are that the structure meets the architectural feature and function satisfactorily, and is reasonable in structural mechanics and construction convenience.

Keywords: space truss structure wind load interaction of upper and lower structures construction sequence analysis

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