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Engineering the Oculus – World Trade Center PATH Transportation Hub

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Abstract

The Oculus structure is the centerpiece of the World Trade Center PATH Transportation Hub in downtown New York City. The main structure consists of two inclined steel arches supported by steel columns, which are anchored onto cantilevers embedded in the transit hall's concrete slabs below. A segmental erection method was proposed to erect the Oculus arches, which significantly reduced the amount of temporary shoring required and allowed construction to proceed at a faster pace. During erection, a detailed geometry control procedure was developed involving multiple survey targets to ensure erection proceeded on the correct path. Bolted connections were proposed in lieu of welding in many locations to accelerate erection. The methodology for bolting such large pieces of steel was developed and designed, then optimized to achieve further schedule improvements.

Keywords: erection engineering, segmental construction, analysis, steel, innovation, architecture, World Trade Center.

1 Introduction

The World Trade Center PATH Transportation Hub (Oculus) is located near the downtown tip of Manhattan in New York City. The structure was designed by Santiago Calatrava and the Downtown Design Partnership engineers (DMJM + Harris, STV Group and Parsons) for the Port Authority of New York and New Jersey. The Contractor, Skanska Koch, Inc. selected Buckland & Taylor International, Inc. (a COWI affiliated company), to provide erection engineering and construction services. The Oculus provides over 200,000 daily commuters access to NJ PATH trains and 13 subway lines, Figure 1.

The Oculus consists of a steel structure dominated by two inclined central arches nominally spanning from east to west across a 94 m-long oval-shaped Transit Hall. The arches are supported by inclined vertical columns called upper portals, which are anchored into the transit hall via steel lower portals, Figure 3. The upper portals raise up to a height of over 30 m in the center of the arches and protrude through the arches to connect to variable length steel rafters that form a pergola-type structure. The arches are supported at either end by large abutments, Figure 4. These steel plate abutment structures serve as surface level entrance portals.

The transit hall is a four-level concrete and steel frame founded upon the Manhattan bedrock and partially surrounded by the World Trade Center

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