

ENTRY FORM



DVASE 2021 Excellence in Structural Engineering Awards Program

PROJECT CATEGORY (check one):

Buildings under \$5M		Buildings Over \$100M	
Buildings \$5M - \$15M		Other Structures Under \$1M	✓
Buildings \$15M - \$40M		Other Structures Over \$1M	
Buildings \$40M - \$100M		Single Family Home	

Approximate construction cost of facility submitted:	Temporary Shoring & Column Jacking: Under \$1M
Name of Project:	Penn Medicine Pavilion Temporary Shoring & Column Jacking
Location of Project:	1 Convention Ave Philadelphia, PA 19104
Date construction was completed (M/Y):	Temp Shoring & Column Jacking 2018-2019; Building Opening 2021
Structural Design Firm:	Thornton Tomasetti
Affiliation:	All entries must be submitted by DVASE member firms or members.
Architect:	N/A for Shoring & Column Jacking (HDR Inc. & Foster+Partners for Penn Medicine Pavilion)
General Contractor:	LF Driscoll & Balfour Beatty

Company Logo (insert .jpg in box below)



Important Notes:

- Please .pdf your completed entry form and email to bsagusti@barrhorstman.com.
- Please also email separately 2-3 of the best .jpg images of your project, for the slide presentation at the annual virtual presentation and for the DVASE website. Include a brief (approx. 4 sentences) summary of the project for the DVASE Awards Presentation with this separate email.

- Provide a concise project description in the following box (one page maximum). Include the significant aspects of the project and their relationship to the judging criteria.

The Penn Medicine Pavilion is a new 16-story hospital facility consisting of 1.5 million-square-feet of built space. Thornton Tomasetti (TT) performed construction and erection engineering services on behalf of the steel erector, Berlin Steel. The two primary services provided by TT included the design of a 90-ft tall temporary shoring structure for erection support of a pair of 32-ft long cantilevered trusses and a column jacking design/procedure for a pair of "removable" columns between level 9-10. Additional scope of services included cantilever framing erection aids, plate girder lifting lugs and rigging design, equipment loading analysis, and temporary stability analysis of the partially complete precast parking garage supporting the steel superstructure during erection.

Temporary Shoring

The rounded north floor plate of the structure at level 3 and above cantilevers 50-ft at its maximum point beyond the last line of building columns that are founded on the mat foundation. The primary support of the cantilevered floor plate consists of two 10-ft deep (chord centerline dimension) trusses that support levels 3 through 9 (floors above level 9 are suspended from a roof truss). These trusses cantilever 32-ft beyond their column line support with the bottom chord of the trusses located approximately 90-ft above the mat elevation. As such, temporary shoring was required in order to support the erection of the trusses until final bolting and welding of the members was completed. The shoring structure was designed as a two column braced frame structure with tie-backs to the building structure in order to limit the footprint of the temporary shoring structure at the mat foundation given site constraints. The location of the columns and tie-backs had to be coordinated closely with the permanent structure and erection sequence. Finally, a truss jacking frame was designed to allow the truss to be jacked and have support shims removed following completion of the truss, after which the temporary shoring was able to be removed.

Column Jacking

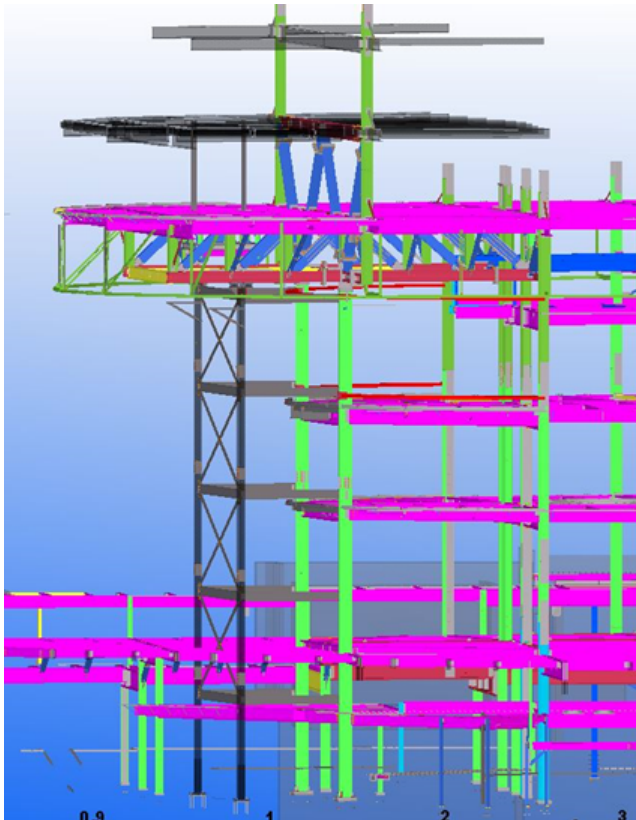
A unique aspect of the final building structure at the cantilevered north end of the building is that levels 3-9 are supported by the cantilevered trusses at level 3 and the floors above level 9 are suspended from a story deep roof truss at levels 15-16. The erection sequence provided by the EOR (HDR) indicated the level 3 trusses were designed to support the weight of the steel structure until the roof trusses were erected. The sequence instructed the erector to provide "removable" columns between level 9-10 at the two northern most columns that could be removed once the roof trusses were erected in order for the final intended load path to be achieved. TT worked closely with the EOR and erector to design a column splice detail and column jacking procedure between level 9-10 to align with the intended sequence. This was achieved by designing a gap into the column splice detail with dimension large enough to accommodate anticipated deflections of the structure calculated by TT during different stages of construction until all floor slabs had been poured. The gap at the column splice was shimmed during erection until the roof truss was completed. Once completed, a column jacking procedure was developed by TT to use hydraulic jacks at the column splice in order to unload and remove the shims at the splice. The final load path was achieved following removal of the shims with the measured gap matching closely to the TT analytical model, indicating the lower trusses supported levels 3-9 and the roof trusses supported level 10 and above. It was required that the final column splice connection have a specified tension capacity so the splice connection designed by TT was able to be utilized both for the temporary condition during erection and the permanent splice condition by utilizing slip critical bolts in long slotted holes.

- The following 5 pages (maximum) can be used to portray your project to the awards committee through photos, renderings, sketches, plans, etc...



Penn Pavilion Cantilevered North End Rendering

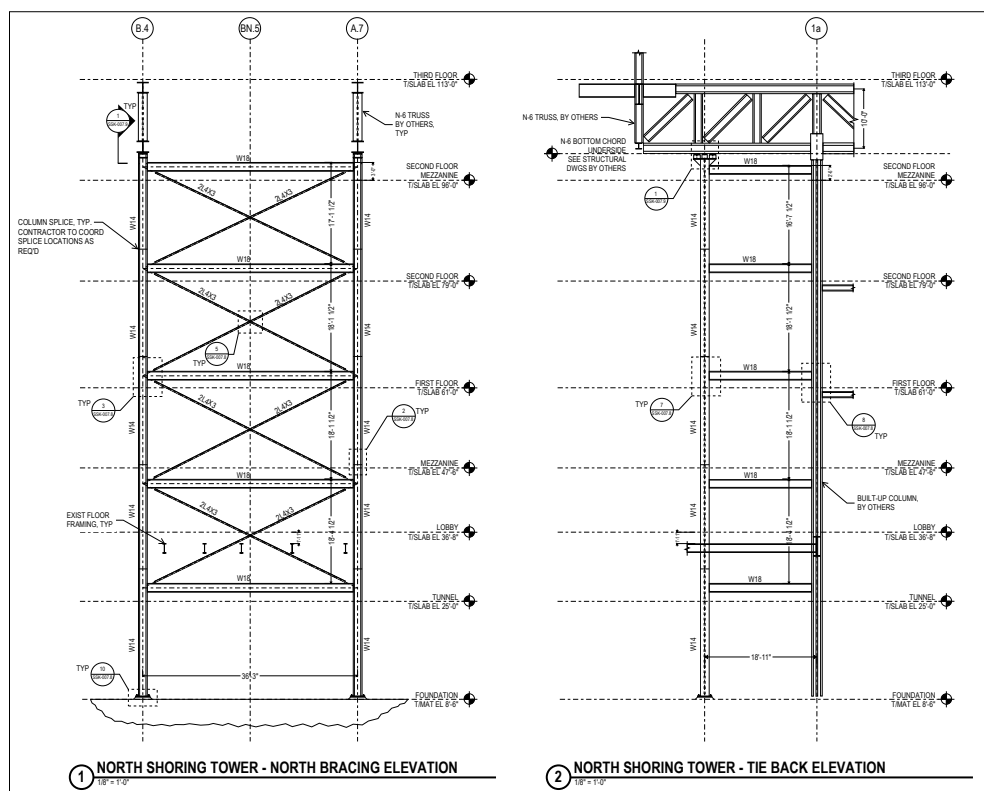
COURTESY OF HDR; FOSTER + PARTNERS



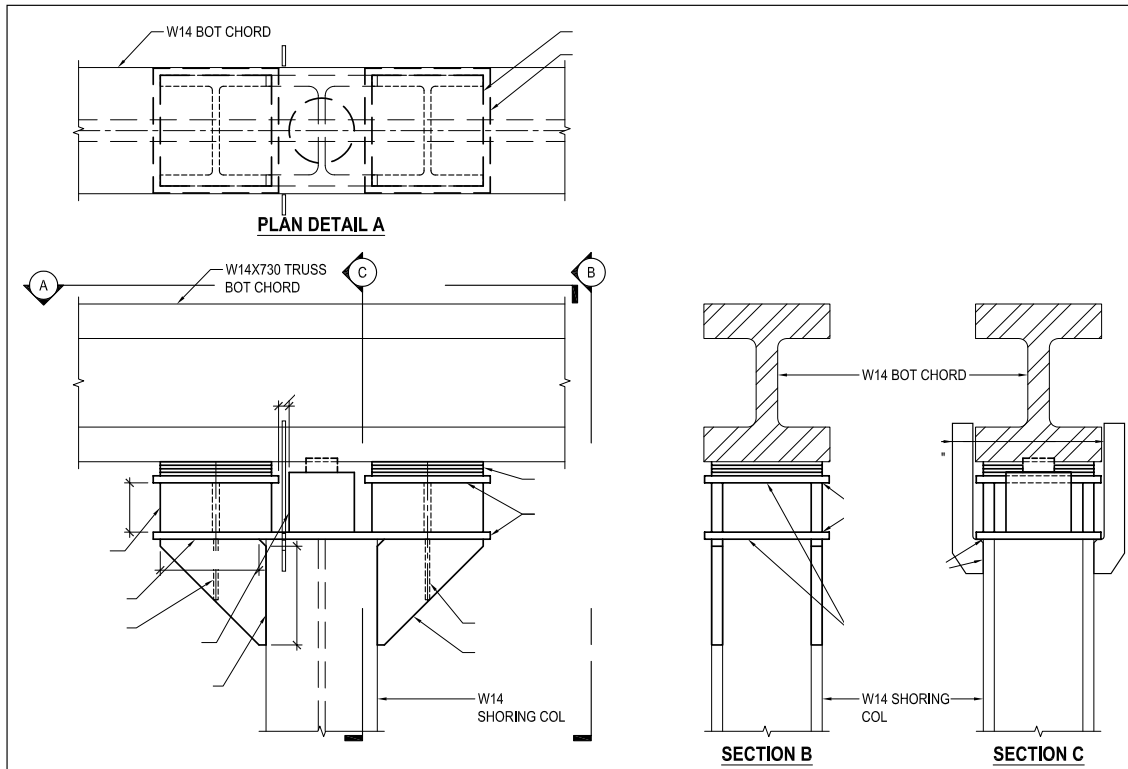
Penn Pavilion Cantilevered North End Truss Temporary Shoring Tower - TEKLA Model & As-Built



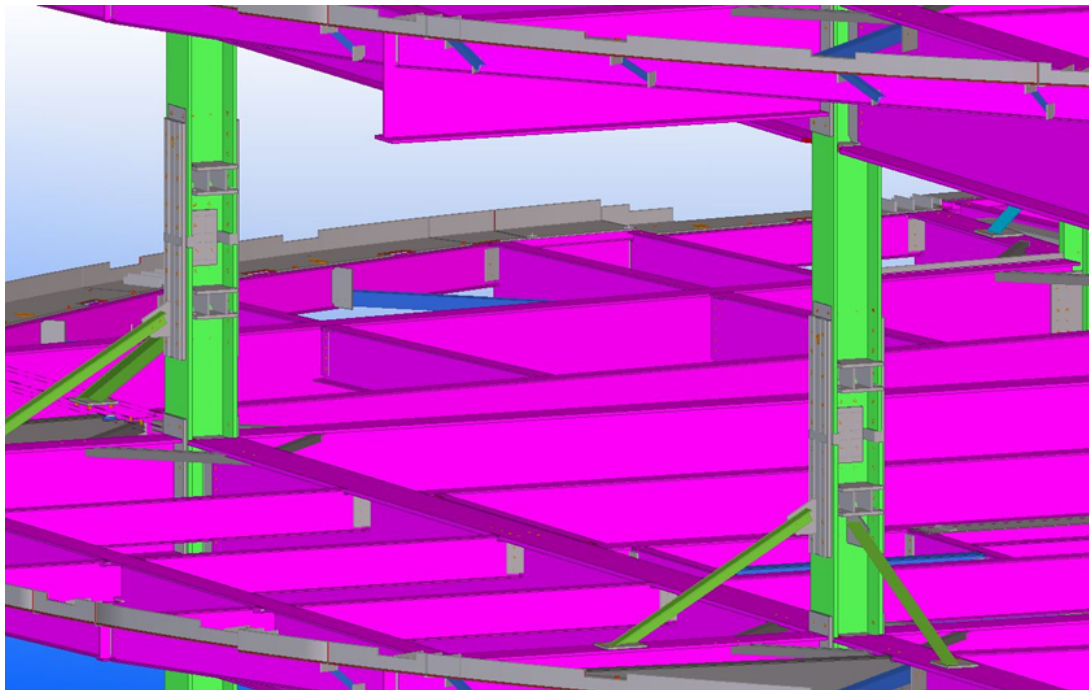
Penn Pavilion Cantilevered North End Truss Temporary Shoring Tower - Aerial View



Penn Pavilion Cantilevered North End Truss Temporary Shoring Tower - Elevation Views from TT Drawings



Penn Pavilion Cantilevered North End Truss Temporary Shoring Tower - Truss Jacking Frame Detail from TT Drawings



Penn Pavilion North End Level 9-10 Column Splice Detail - TEKLA



Penn Pavilion North End Level 9-10 Column Splice Detail - Shimmed Gap & Tightened Bolts During Erection



Penn Pavilion North End Level 9-10 Column Splice Detail - Jacking Setup Before & During (Splice Bolts Loose)



*Penn Pavilion North End Level 9-10 Column Splice Detail - After Jacking with Shims Removed
(Bolts Loose with Sustained Gap)*

By signing, signatory agrees to the following and represents that he or she is authorized to sign for the structural design firm of record.

All entries become the property of DVASE and will not be returned. By entering, the entrant grants a royalty-free license to DVASE to use any copyrighted material submitted.

If selected as an award winner, you may be offered the opportunity to present your project at a DVASE breakfast seminar. Would you be willing to present to your colleagues? ☐ **YES** ☒ **NO**

Submitted by:

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