Fermilab

Particle Physics Division
Mechanical Department Engineering Note

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Project Internal Reference:

Project: Facility

Title: Portable Gantry Crane Modifications – Height Increase.

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Abstract Summary:

An existing portable gantry crane (presently used in the MINOS access tunnel) has again proven too short for use with detector geometries planned for this area. So, the side post extensions were replaces with longer lengths of pipe. This note documents the calculations.

Also See engineering note 136 for this same gantry crane.

Applicable Codes: AISC 9th edition

Discussion:

Gantry Crane Specifics:

Capacity	1.5 tons
Present number of hoists:	2
Hoist Capacity	1 ton each
New Height to bottom of beam:	16 feet
Post Center to Center Distance:	12 feet 6 inches
Wheel Base	6 feet 0 inches

Original Side Post Uppers: 3.5 inch nominal diameter, schedule 40 carbon steel pipe.

New Side Post Uppers: 4 inch nominal diameter, schedule 10S stainless steel pipe. Yield stress of the stainless steel pipe material is 30,000 psi.

Side Post bottom segments: 4 inch nominal diameter, schedule 40 carbon steel pipe. Yield stress of the carbon steel material is assumed to be 30,000 psi although stronger material may have been used.

Original design used a smaller diameter upper post siding into the larger diameter lower post and held in place with a horizontal pin. The loose fit between the upper (inner) and lower (outer) posts allowed some slop in this connection.

New design uses a pair of plates welded to the top of the lower post and to the bottom of the new upper post and joined with four bolts. These plates serve to align to upper and lower posts. Axial load is transferred in bearing from the bottom of the upper post directly to the top of the upper post.

The four (4) bolts joining plates are size 3/8-16 and grade 5 material.

Gantry crane is not intended to be loaded with lateral loads. Standard operating procedure is to use C-clamps and unistrut beams to connect the left and right lower side posts and the load when the gantry is moved while loaded. This transfers the lateral loads from the load inertia directly to the base and avoids putting a bending moment on the columns.

Calculations for the new upper posts:
Cc = sqrt ((2pi^2*E)/Fy) = sqrt ((2*pi^2*29x10^6)/30,000) = 138.1

Radius of Gyration, r = ¼*sqrt(o.d ^2 + id^2) = ¼*sqrt(4.5^2+4.26^2) = 1.54 in

K = 1.0 (see case (d) in AISC 9th, Chapter C, Section C-C2 on page 5-135)

L = 96 inches

KL/r = 1.0 * 96 / 1.54 = 61.9

Since Cc > KL/r, use formula E2-1:

Allowable stress, Fa = [1- ((KL/r)^2/(2*(Cc^2))]*Fy / {(5/3) + (3/8)*(KL/r)/(8*Cc) – ((KL/r)^3)/(8*(Cc^3))}

Fa = .899*Fy /{1.67+0.168-0.0113} = 0.49 Fy = 0.49 * 30,000 psi = 14,800 psi

Area of upper pipe, A = s 1.651 square inches

Allowable load, P = A * Fa = 1.651 * 14,800 = 24,400 pounds.

This greatly exceeds the capacity of the other components of the fixture, therefore satisfactory.

Photographs of the portable gantry crane as modified: