Fermilab

Particle Physics Division

# Mechanical Department Engineering Note

Number: MD-ENG-312 Date: January 19, 2011

Project:

Project Internal Reference:

Title: E906 Beam Dump Shielding Cave

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Reviewer(s):

Key Words: E906, Beam Dump, Shielding Cave

Abstract/Summary:

Due to lack of overhead crane coverage, two standard "J" shield blocks were reoriented from a vertical position to a horizontal position. These "J" blocks support two layers of "H" blocks that cantilever out 54 inches perpendicular to the "J" block's span. This note investigates if these two "J" shield blocks, stacked on top of each other with their 36 inch dimensions horizontally, can replace the vertically oriented "J" blocks.

Applicable Codes:

*Building Code Requirements for Structural Concrete (ACI 318-02),* American Concrete Institute, Farmington Hills, Michigan.

E 906 BEAM DUMP

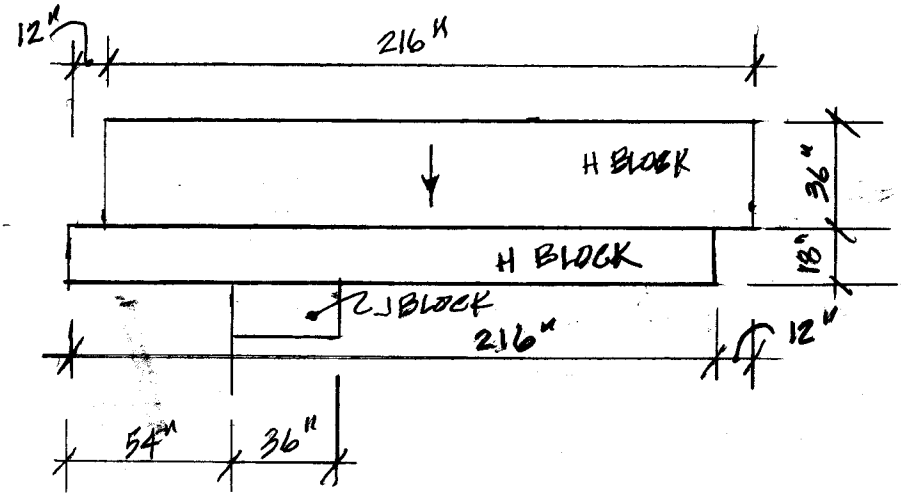
SHIELDING CAVE

R. J. WOODY
JAN. 19, 2011



CHECK LOAD ON "J" BLOCK FROM CANTILEVERED "H" BLOCKS ABOVE:

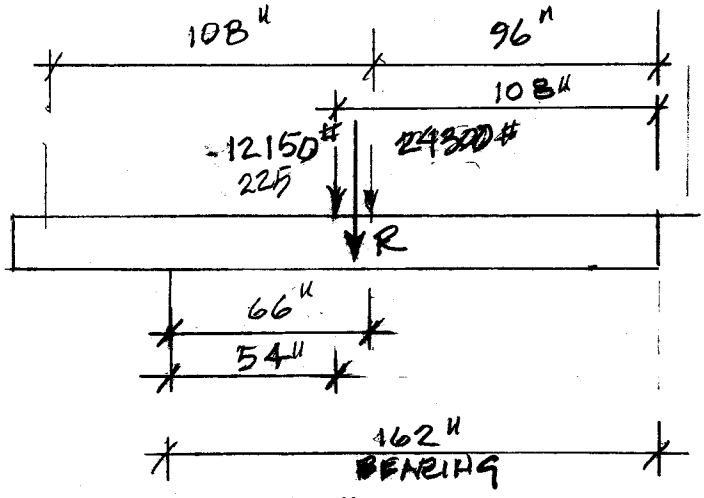
SIDE VIEW:




LOADS FOR 36" "J" BLOCK SPAN

H BLOCK VERT = 2(18 x 36 x 216)/1728(150) = 24300 #

H BLOCK HORIZ = 1(18 x 36 x 216)/1728(150) = 12150 #




RESULTANT LOAD "R"

R = 24300 + 12150 = 36450

FIND DISTANCE FROM RIGHT END:

(108 x 12150) + (96 x 24300) = 3645000

3645000/36450 = 100"

FIND MAX. & MIN. FORCE:

$$A = \frac{d(b+b_1)}{2}$$

$$36450 = \frac{162''(b+b_1)}{2}$$

$$450 = (b+b_1)$$

$$450 - b_1 = b$$

$$c = \frac{d(2b+b_1)}{3(b+b_1)}$$

$$100 = \frac{162(2b+b_1)}{3(450)}$$

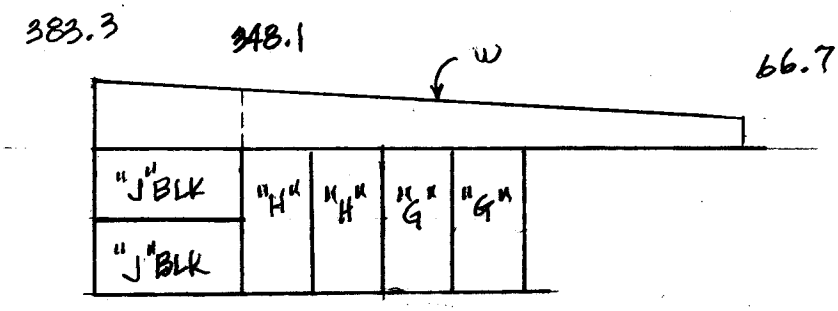
$$833.3 = 2(450 - b_1) + b_1$$

$$833.3 = 900 - b_1$$

$$-66.7 = -b_1$$

$$66.7 = b_1 \quad \text{(FOR 3'-0" LENGTH)}$$

$$383.3 = b \quad \text{(FOR 3'-0" LENGTH)}$$




LOAD ON END "J" BLOCKS:

RATE OF LOAD DECREASE:

$(383.3 - 66.7)/162 = 1.95$ #/36"/IN

LOAD @ RIGHT EDGE OF "H" BLOCK

$383.3 - 36(1.95) = 312.9$ #/36"/IN

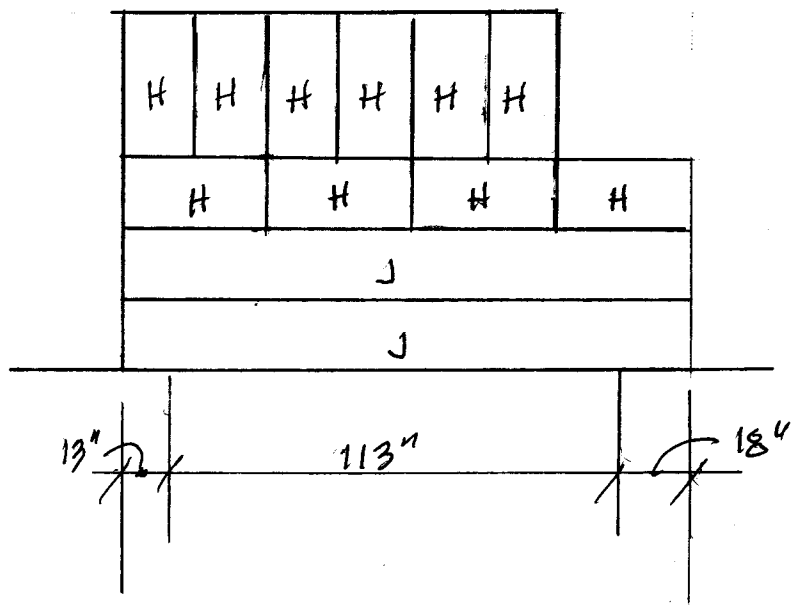
$$H = \frac{36(383.3 + 312.9)}{2} = 12531.6 \text{ \#/36"}$$

$$= 348.1 \text{ \#/IN}$$

SINGLE "J" BLOCK LOAD $= 18(36)/144\,(150) = 675$ #/FT

$= 56.3$ #/IN

END VIEW:




BEAM SPAN = 113" $\quad w = 348.1 + 2(56.3) = 460.7\,\#/IN$

$$R_L = R_R = 460.7(113)/2 = 26030\,\#$$

$$M_u = 1.4(460.7)(113)^2/8 = 1029469\,\#\text{-IN}$$

CAPACITY OF "J" BLOCK

$f'c = 5000$ PSI $\quad f_y = 60{,}000$ PSI

$h = 18"$ $\quad b = 36"$ $\quad L = 144"$ $\quad A_s = 4$-#6 BARS $\quad A_s = 4(0.44) = 1.76\,IN^2$

$d = 18 - 2.75 = 15.25"$

$$a = \frac{A_s f_y}{0.85 f'c\, b}$$

$$= \frac{1.76(60)}{0.85(5)(36)} = 0.690$$

$$M_n = \phi A_s f_y (d - a/2)$$

$$= 0.9(1.76)(60)(15.25 - 0.690/2) = 1417\ K\text{-IN}$$

$$= 1{,}417{,}000\,\#\text{-IN}$$

FOR 2 "J" BLOCKS:

CAPACITY = 1,416,700 X 2 = 2,834,000 #-IN > 1,029,469 #-IN

OK

CHECK SHEAR:

$R = 26030\#$ $\quad V_u = 1.4(26030)$
$= 36442\#$

$V_c = 2\sqrt{f'c}\, b_w d$
$= 2\sqrt{5000}\,(36)(15.25)$
$= 77640$ psi

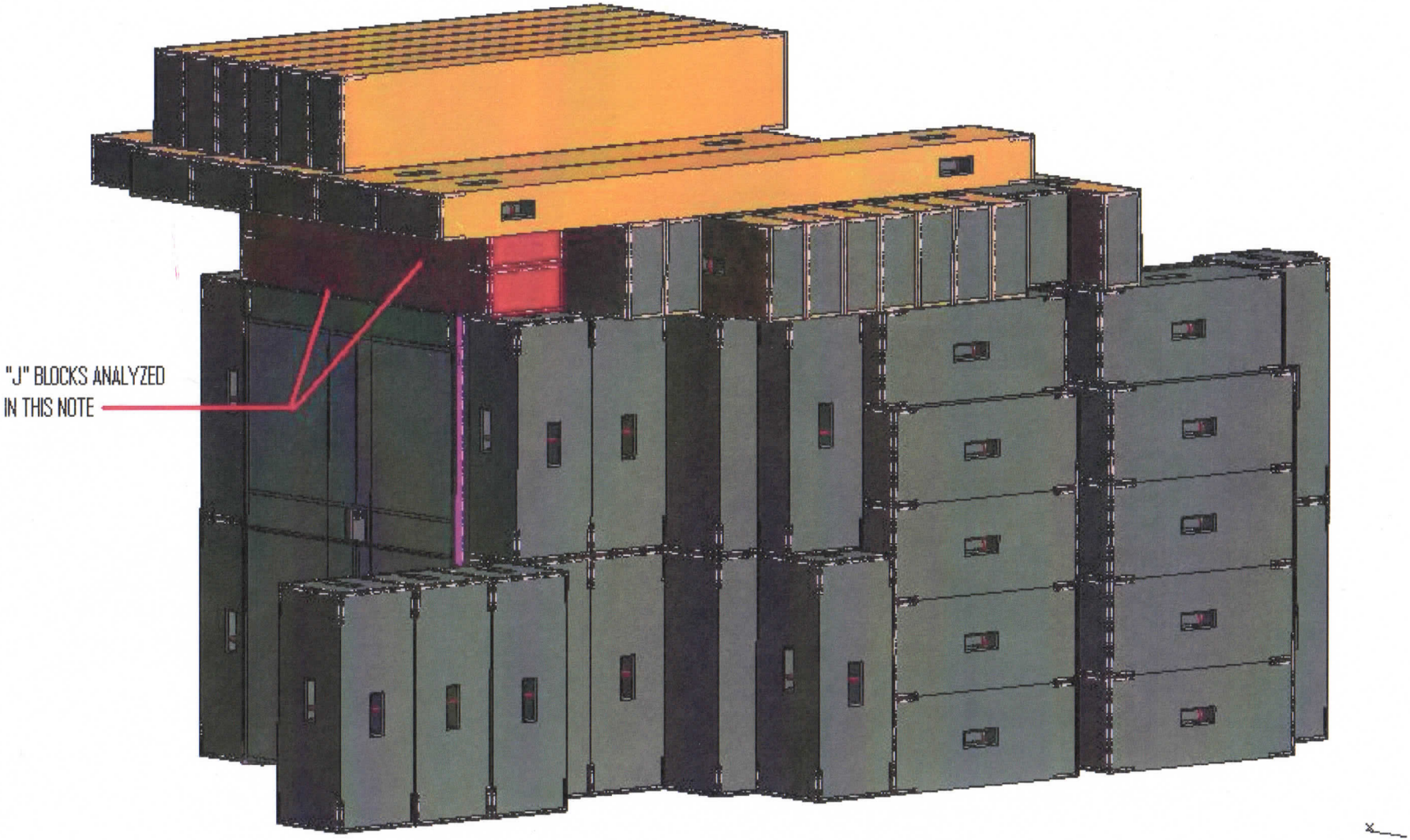
$V_n = V_c$

$\phi V_n \geq V_u$

$0.75(77640) \overset{?}{>} 36442$

$58230 > 36442$ ok

2 "J" BLOCKS OK AS SHOWN


"J" BLOCKS ANALYZED
IN THIS NOTE