Joel Misek
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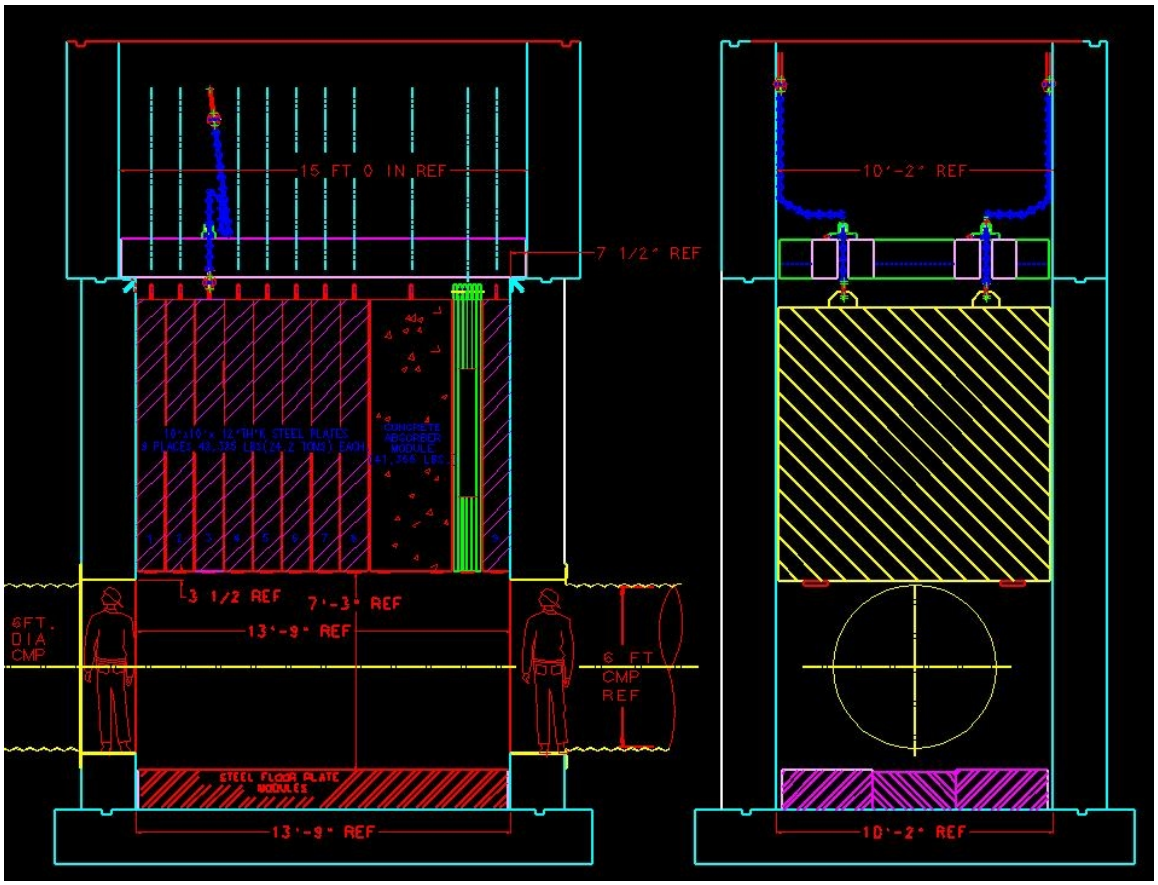
MiniBooNE
25 meter Absorber
Overhead Loads

To access the downstream portion of the decay pipe for MiniBooNE requires that personnel walk under the loads that are suspended within the 25 meter enclosure. Entry would only be to access the other side of the enclosure. No work would be performed in the enclosure under the loads.

25 METER ABSORBER - ELEVATION & CROSS-SECTION



The following describes the hardware that constitutes the load and support structure. I viewed the total installation and can verify that the installation followed the design.

Modules:

The load is comprised of 10 steel modules (25 tons each) and one concrete module (22 tons). Each steel module is made up of 6 individual 2” thick steel plates that are welded to each other.

STEEL MODULE WITH SUPPORT CHAIN ASSEMBLIES

The quantity of weld is approximately 48 lineal inches of 3/8” fillet. This gives conservatively 12 sq. in. of weld area. The maximum load that these welds would see is 16800 lbs (2 plates). This gives a very small shear stress of 1400 psi.

The concrete module design was incorporated in the MiniBooNE construction contract. See drg. 6-7-55 SC-19.

CONCRETE MODULE WITH LIFTING CHAIN ASSEMBLIES

Module lifting Lugs:

The two lifting lugs which are attached to the 6 plate module are made from 1.25" thick A36 steel plate. The two lugs are welded to the module with multiple passes of 7018 welding rod to give a fillet size of 1/2". This weld has a perimeter of 26 in. giving a weld area of 9 sq. in. The load supported by one of these lugs is 25,000 lbs. This gives us a tensile stress in the weld of 2,800 psi. The lug has a 1.75 dia hole for attachment of the lifting chain hardware couplings. The shear tearout stresses of the coupling will be the load divided by the thickness of the lug x the hole to edge distance x 2 (either side of lug). This gives a value of 7,250 psi. Due to the circular shape of the coupling, there will be some local yielding as the coupling contacts the inner surface of the hole. To quantify this, a test specimen was set up and loaded with 25,000 lbs. and 60,000 lbs. The amount of yielding in the first case was only slightly detectable. In the second case an area of 0.6 sq. in. was measured. No plastic bending was observed at the edge nearest the hole in either case.

TEST LUG LIFTING HOLE AFTER 60,000 LB. LOADING

STEEL MODULE LIFTING LUG CHAIN ATTACHMENT

The concrete module reinforcing design was completed by FESS. The lug design used a plate of 1.0 in. thickness. To be consistent with the steel module lugs, a steel bar was added to the lug at the edge nearest the edge

to give the same shear tearout stresses as with the steel modules. This shear tearout stress is 7,300 psi.

CONCRETE MODULE LIFTING LUG WITH CHAIN ATTACHMENT

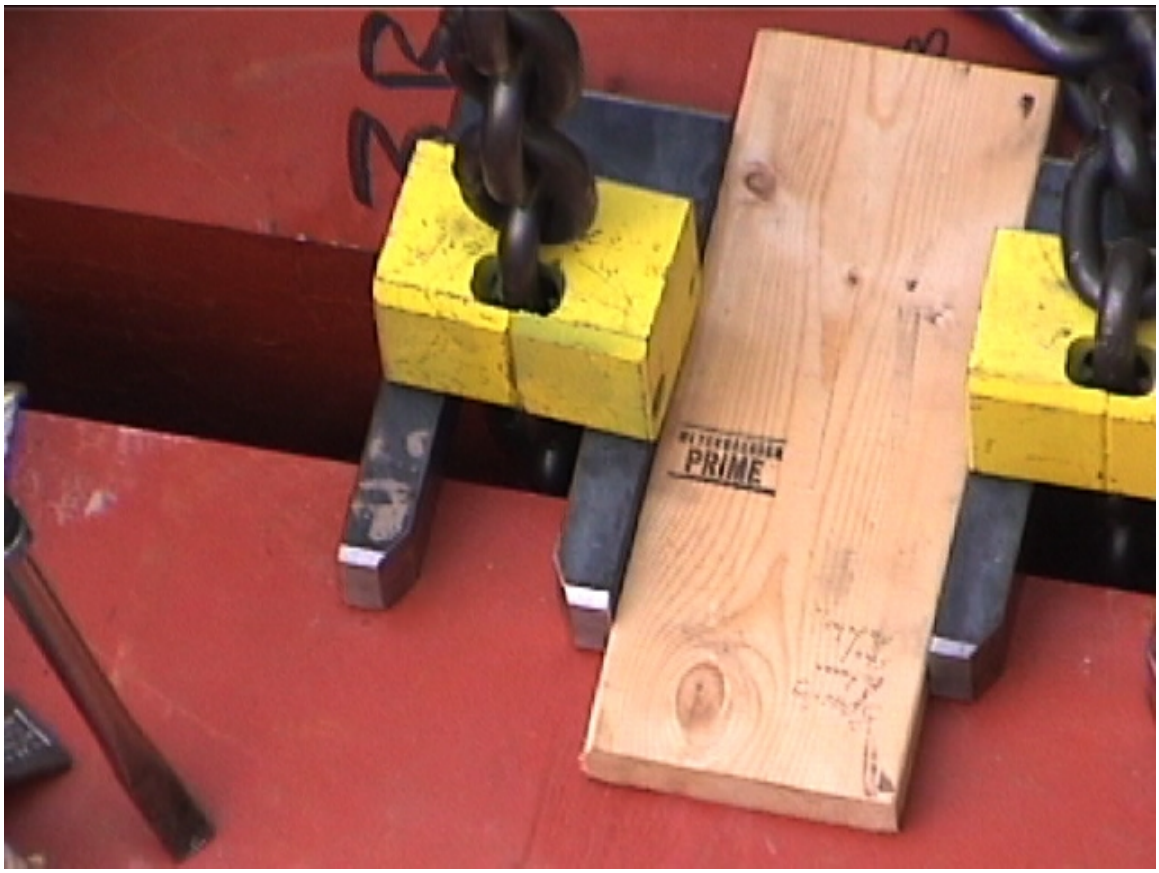
Chain Assemblies:

The chain assemblies are commercially purchased and tagged for a working load of 34,200 lbs. each.

Chain Blocks/ U-blocks:

The loaded chain assembly is blocked in the raised position with a combination of a split bolted assembly and a u-shaped block.

CHAIN AND U-BLOCKS RESTING ON SUPPORT BEAMS
(wood spacer block is removed after installation)



The stresses on the U shaped block are shear of 1,650 psi and a worst case bending of 24,000 psi. The U-shaped block is made from 4140 steel with a yield stress of 90,000 psi. The split chain block assembly sees primarily bearing stresses where the chain contacts. The bolts which hold the blocks together are stressed to 27,650 psi (6250 lbs tension each). These bolts are 5/8 - 11 grade 8 with a minimum tensile strength of 170,000 psi. The bolts were torqued to 100 ft- lbs (10,000 lbs tension) and locktite applied to the threads. The bolts were retorqued at installation and viewed personally by myself. The previous load test of the module lifting lug also tested the chain blocks at 2.4 times working load (60,000 lbs). No deformation was observed in either the blocks or the bolts.

DISASSEMBLED CHAIN CLAMP BLOCK

Support Beams:

The chain blocks/U- blocks are supported on four 17” x 11” solid steel beams which in turn are supported at their ends in the enclosure.

INSTALLATION OF FIRST SUPPORT BEAM

COMPLETE INSTALLATION OF 4 SUPPORT BEAMS & SHIELDING

A bending analysis calculates the stress level in these beams to be 5,760 psi. with a deflection of .065”. Shear stresses and torsional stresses were calculated to be 363 psi and 320 psi respectively. The beams were fabricated from “on hand” surplus steel. Since no documentation was present on this material, samples were sent out for chemical analysis and mechanical testing. The results of these tests showed that the material was 1008 steel with ultimate tensile and yield values of 33,000 psi and 28,000 psi respectively. These samples were taken directly from the finished beams one from each of the four beams.

TWO SUPPORT BEAMS SHOWING NOTCH REMOVED FOR TESTING

To insure that there were no inclusions or delaminating of the steel (none was evident when machining the beams), the beams were load tested. The load test configuration was modeled and showed a bending stress of 7080 psi with a deflection of .083”. Both sets of beams were tested in the same manner. Each pair of beams were loaded with 18 “Blue Blocks” (a weight of 10 tons each) for a total weight of 180 tons.

LOAD TEST OF TWO SUPPORT BEAMS

The deflections from the test were monitored with dial indicators and optical survey. The deflections were consistent with the model within the accuracy of the measurements (+/- .005”). In addition, the beams were left loaded for 3 days without any noticeable increase in deflection.

CLOSEUP VIEW SHOWING LOAD POINTS & DIAL INDICATORS

CONCLUSIONS

The design of the 25 meter Absorber is relatively conservative. The initial design criteria did not assume that the region below the loads would be a manned area but the above discussion shows that adequate safety margins exist for a “one time” access through this area. Any activity beyond this would require further discussion.