Commercial Building First Floor Structural Capacity Evaluation

Location:

Prepared for:

Prepared by:

A.S. Engineering Services, P.C.

112 Wilson Drive

Port Jefferson, New York, 11777

Engineer of Record:

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Results and Conclusions

Based upon the information obtained and relied upon to date, we offer the following opinions:

1) The live load capacity of the floor system over the basement area of the building is 100 pounds per square foot.

2) The live load capacity of the concrete slab-on-grade floor system is 125 pounds per square foot as well as a 2000 pound rated forklift with a maximum 7,200 pound axle static load and wheel spacing of 32 inches on center.

3) The physical evidence observed at the property indicated that the floor system over the basement area was in relatively good condition. An area of concern was noted:

    a) The metal floor deck was visibly stained and rusted in several locations. This occurred primarily adjacent to the rear wall. The roof and exterior wall as well as floor area directly above should be further investigated to determine if this is the result of an on-going systemic leak.

Introduction

A.S. Engineering Services, P.C. was retained by, , to perform a structural evaluation of the existing first floor to determine allowable live load capacity. Our work to complete this assignment was performed by Alex Spyrou, PE on April 18th, 2014. site manager, was present during our inspection and provided some of the information pertaining to the building. All measurements and data cited in this report are considered to be approximate values and are based on readily available visual evidence. Minimal destructive testing was performed as part of this evaluation.

Background Information

Mr. Smith reported that the building was constructed in the1970's and that it had been vacant for some time. Mr. Smith was interested in determining the structural capacity of the first floor system to prevent potential future issues.

Site Observations

The subject building was 1-story commercial building with concrete masonry units (CMU) exterior walls on a concrete slab on grade foundation for a majority of the building. A small portion of the first floor was over a basement and the roof framing consisted of open web steel bar joists with steel girders and columns. The building was approximately 93,000 square feet and the basement area was approximately 11, 000 square feet. For the purpose of this report, the front of the building was referenced to face west.

The basement area was located along the rear east side of the building. It appeared that only a portion of the vacant, Khols retail space, was located over the basement area. The remainder of the basement area appeared to be below the occupied space and consequently we could not observe the first floor in that area of the building. The basement ceiling framing consisted of steel beams with a 1.5 inch metal deck supporting a total slab thickness of 6 inches. The steel framing was supported by steel columns which were spaced at 15 feet on center in the north-south direction and 30 feet on center in the east-west direction. The columns on the first floor, supporting the roof framing, were spaced at 30 feet on center consequently every other basement column also supported roof framing. We observed along the opening in the first floor adjacent to the basement stairs that the concrete floor slab was 6 inches thick. We were unable to drill a hole in the slab-on-grade portion of the building due to no electrical access in that area. Most of the floor slab was covered with an interior finish surface and therefore we could not confirm control joint size and spacing but where visible the floor slab was in good condition and no significant cracking was observed. Within the basement of the building several areas, primarily along the rear east wall of the building, the metal floor deck was observed to be either stained or slightly deteriorated. Since the area above was located in the Marshalls portion of the building, it could not be further investigated.

Analyses and Discussion and Conclusions

The physical evidence observed at the property and reported information indicated that the first floor system was in relatively good condition and the capacity was determined as follows:

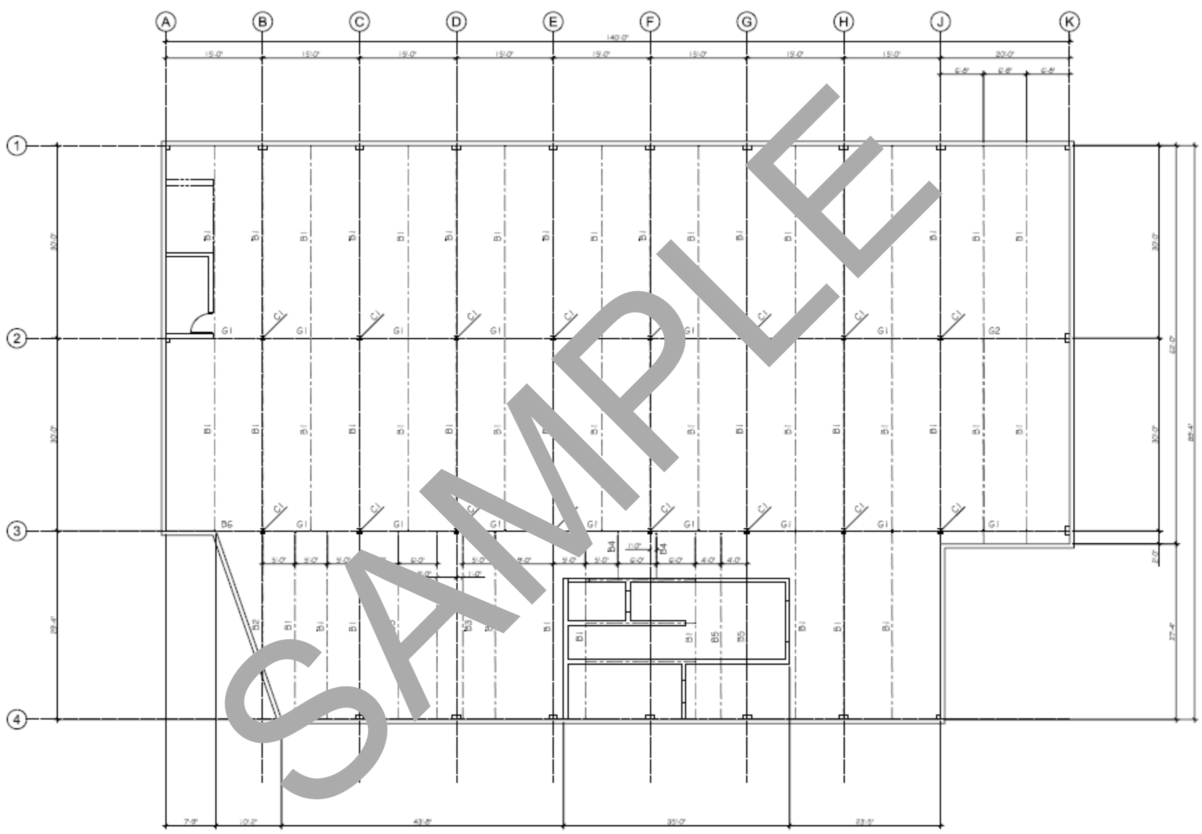
Assumptions and Design Criteria

The following assumptions, loads and limitations were made in our analysis:

- A36 Steel Members
- Non-Composite steel framing members
- Total 6 inch thick concrete slab-on-grade
- 18 gage 1.5 inch Non-Composite metal deck with a total 6" concrete floor for the basement ceiling
- 3000 pounds per square inch concrete compressive strength
- 3/4 inch diameter A325 bolts
- slab reinforcement in basement ceiling framing is "draped"
- Subgrade Modulus = [illegible]00 lbs/inch^3
- Collateral load of 15 pounds per square foot to account for mechanical systems
- Partition load of 15 pounds per square foot
- Line Load of 650 plf where full height CMU walls were observed - we assumed 8" CMU grouted @ 48" o.c.
- Roof load of 30 pounds per square foot was utilized for point load on columns supporting roof framing
- Footings were not checked and are outside the scope of this report

Basement Ceiling

The entire floor system field measured and modeled based on the as-built conditions determined from our site visit in order to determine the allowable live load capacity based on the criteria defined above. The analysis included an evaluation of the floor framing system, metal deck and concrete slab and connections of the individual steel framing members.



FRAMING PLAN

COLUMN (C) SCHEDULE		
MARK	MEMBER	REMARKS
C1	W8 x 48	

GIRDER (G) SCHEDULE		
MARK	MEMBER	REMARKS
G1	W24 x 62	
G1	W27 x 84	

BEAM (B) SCHEDULE		
MARK	MEMBER	REMARKS
B1	W24 x 62	
B2	W14 x 22	
B3	W21 x 44	
B4	W14 x 22	
B5	W18 x 50	

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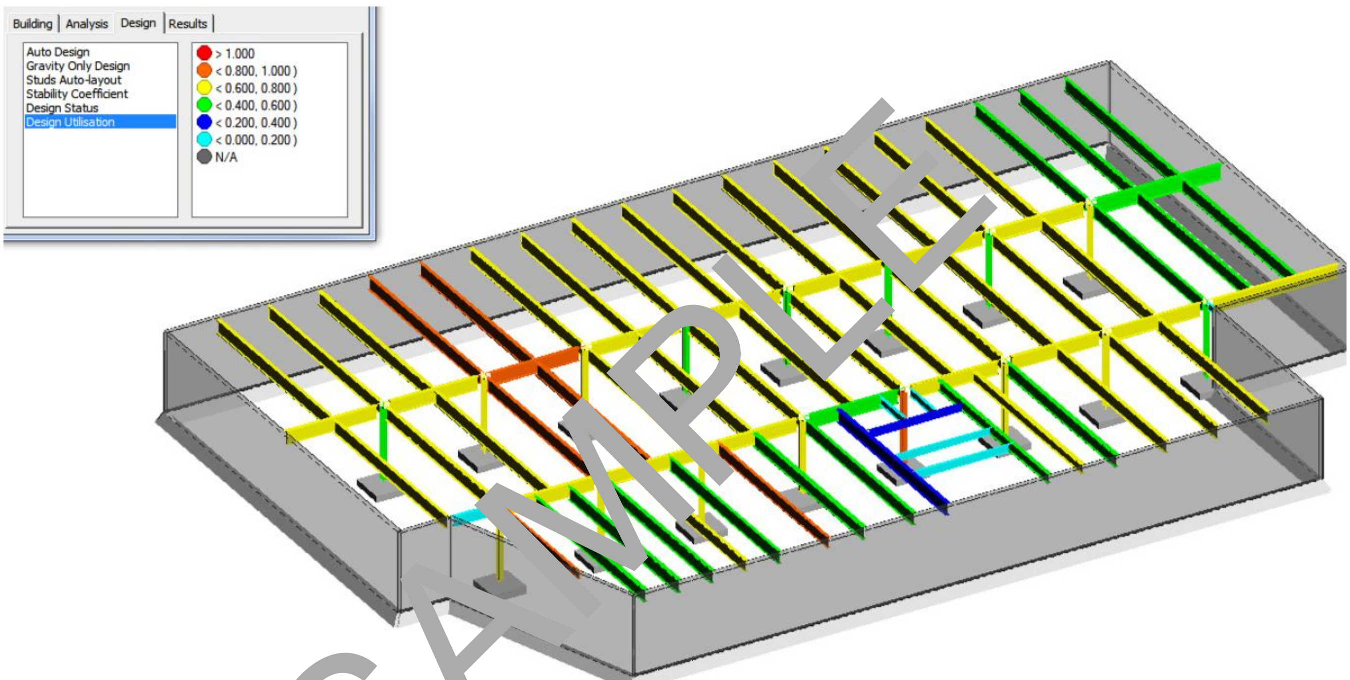
Floor Framing System

The steel floor framing system has a live load capacity of 100 pounds per square foot.

The figure below shows the utilization of each framing member based on the criteria defined above and a 100 psf live load.



Connections

The typical condition for each type of connection was analyzed to determine if the connections were the limiting capacity. The connections have a capacity of nearly 4 times the actual load.

Concrete Slab-on-Grade

The concrete slab-on-grade was determined to have a capacity of 125 psf and can support a 2000 pound rated capacity forklift load with a maximum 7,200 pound axle static load and wheel spacing of 32 inches on center. Design assumes a 100 psi tire inflation.

Representative photographs are included in this report. The photographs taken but not included in the report are available upon request.

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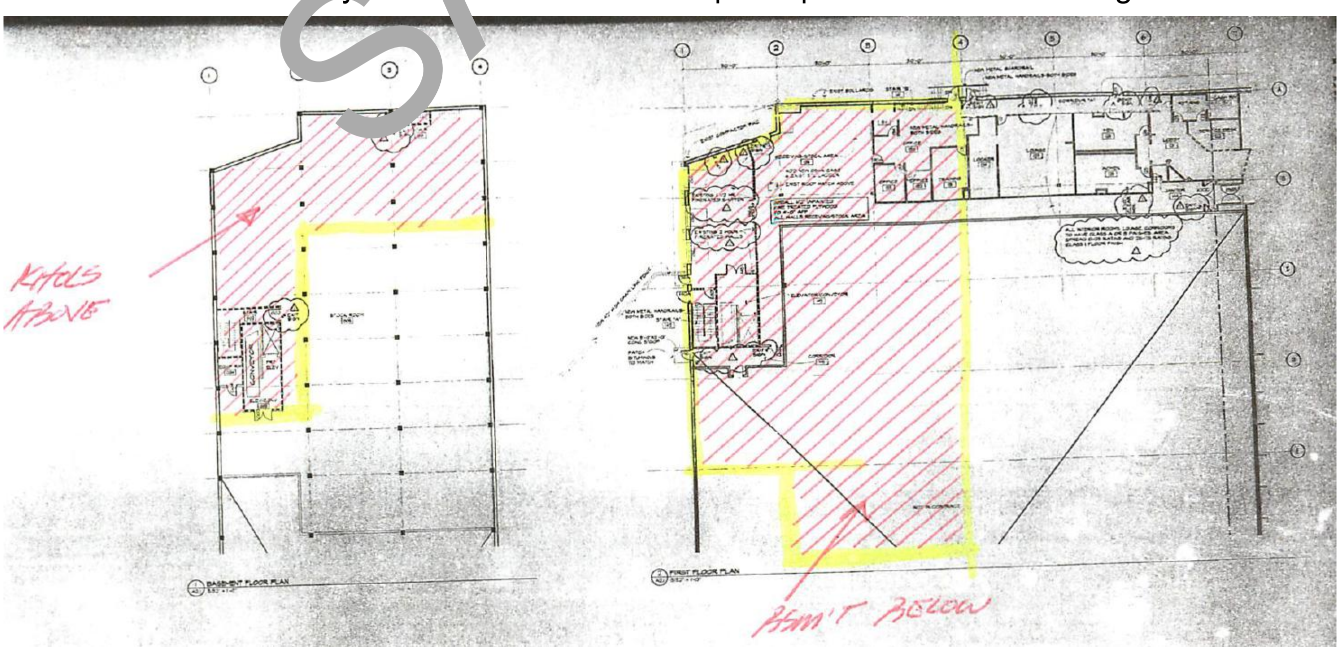
Photographs

Photograph 1

View of the front (west) side of the subject building.

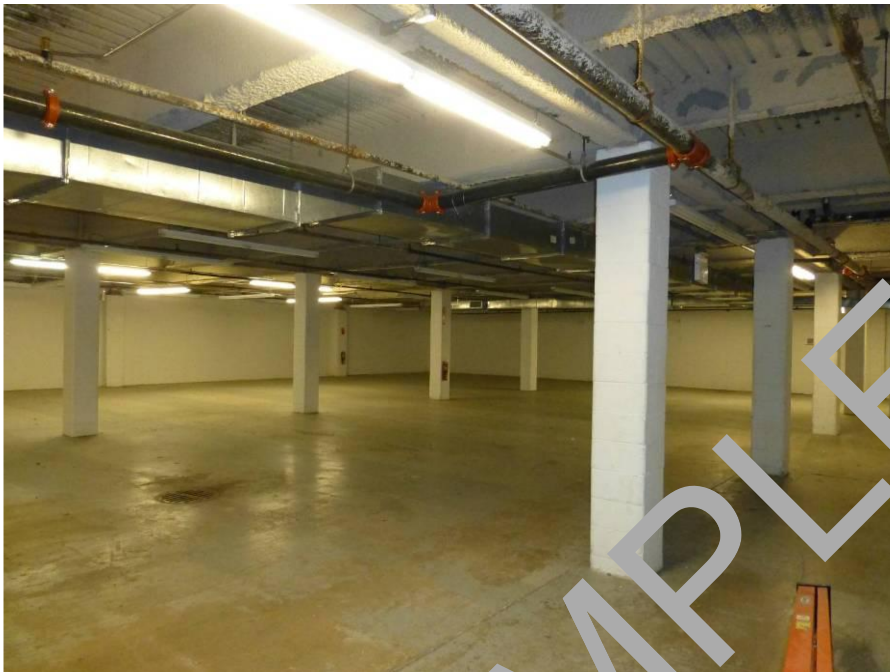
Photograph 2

View of the basement layout relative to the unoccupied space within the building.



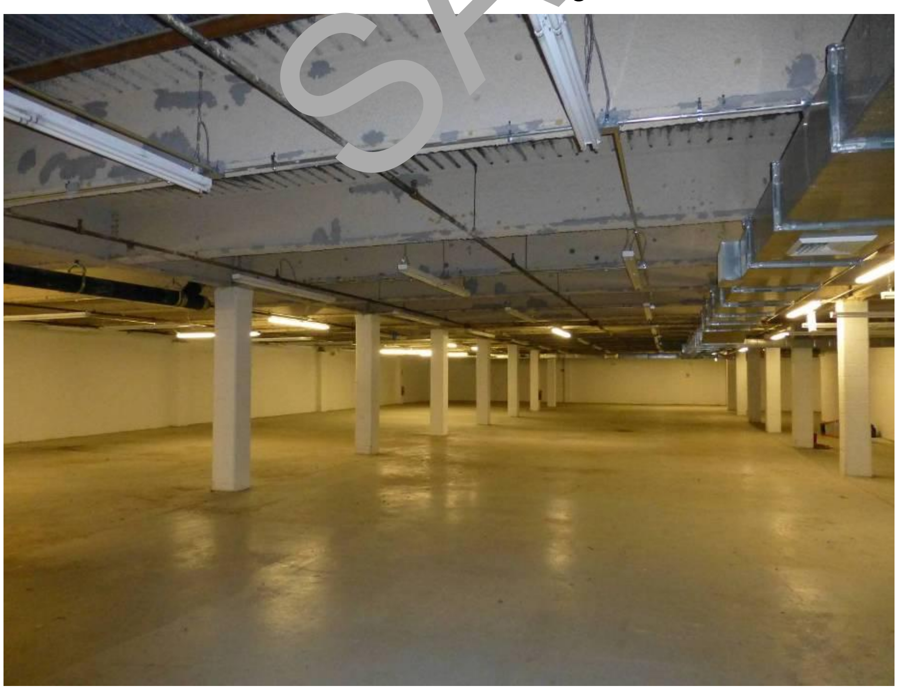
Photograph 3

View of the basement area of the building.



Photograph 4

View of the basement area of the building.



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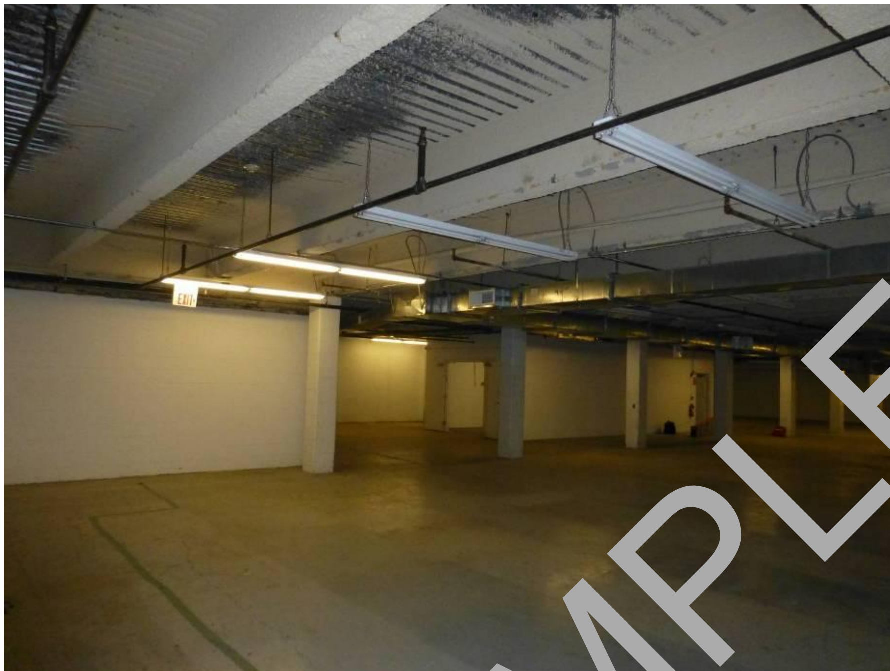
Photograph 5

View of the basement area of the building.

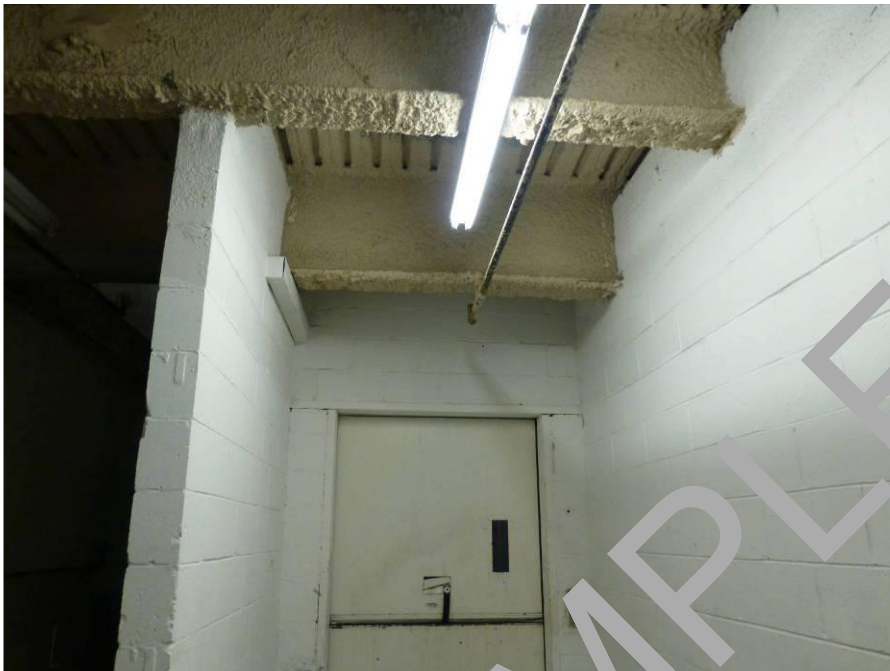


Photograph 6

View of the elevator and material handling room of the basement area of the building.

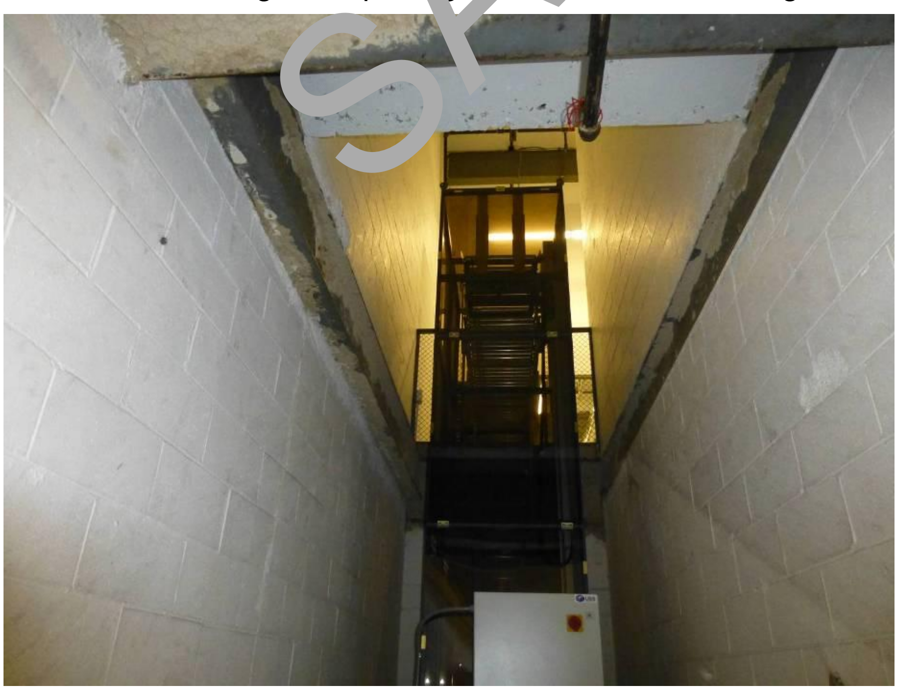
Photograph 7

View of the framing adjacent to the freight elevator of the basement area of the building.



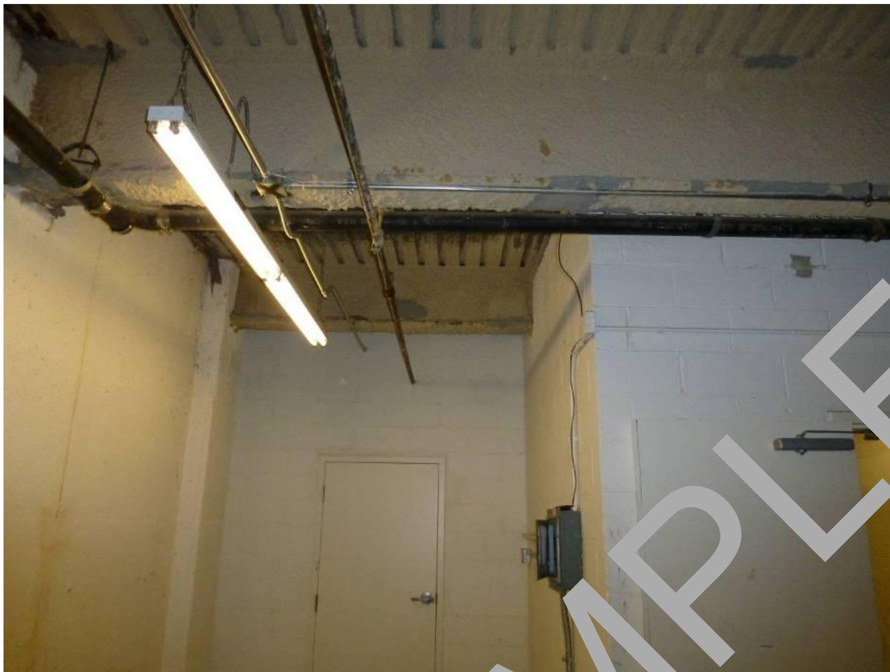
Photograph 8

View of the framing and opening of the material handling area of the building.



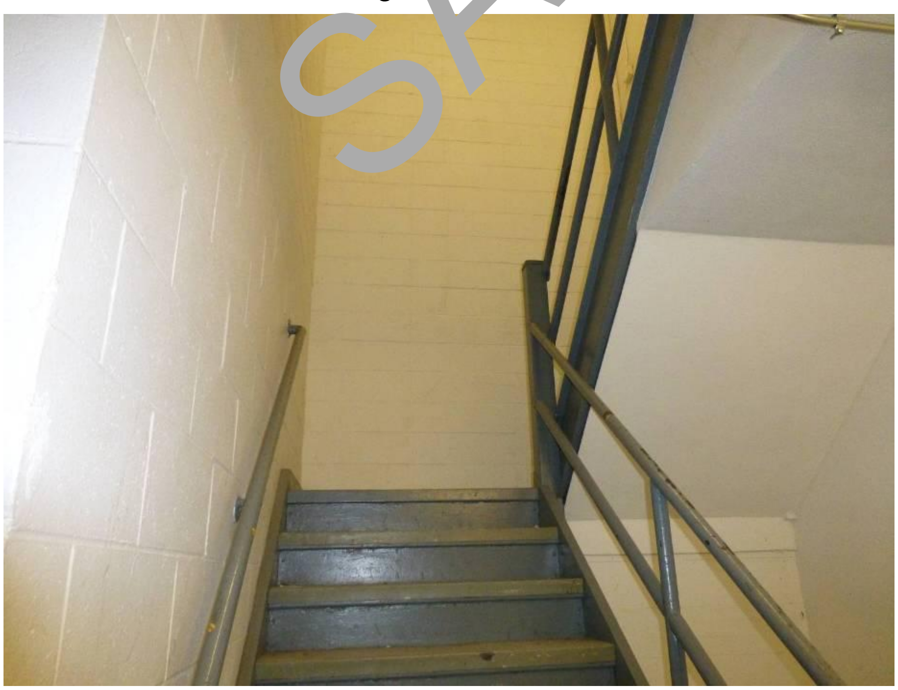
Photograph 9

View of the framing near the rear wall of the basement area of the building.



Photograph 10

View of the stairwell leading to the basement area of the building.



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Photograph 11

View of a typical beam to column condition of the first floor framing.

Photograph 12

View of a typical beam pocket support of the first floor framing members.

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Photograph 13

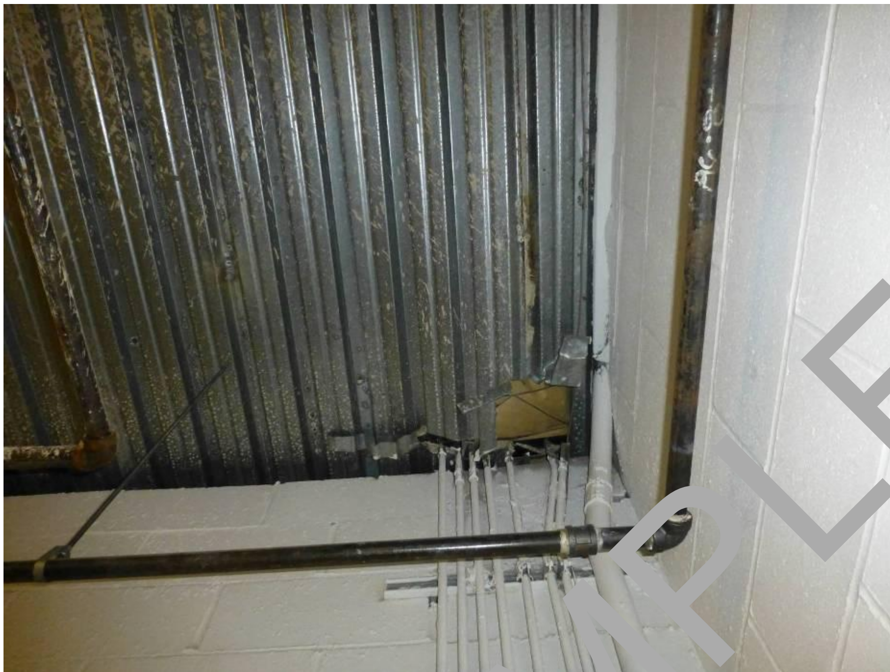
View of a typical steel column encasement in the basement of the building.

Photograph 14

View of a typical beam to girder connection.

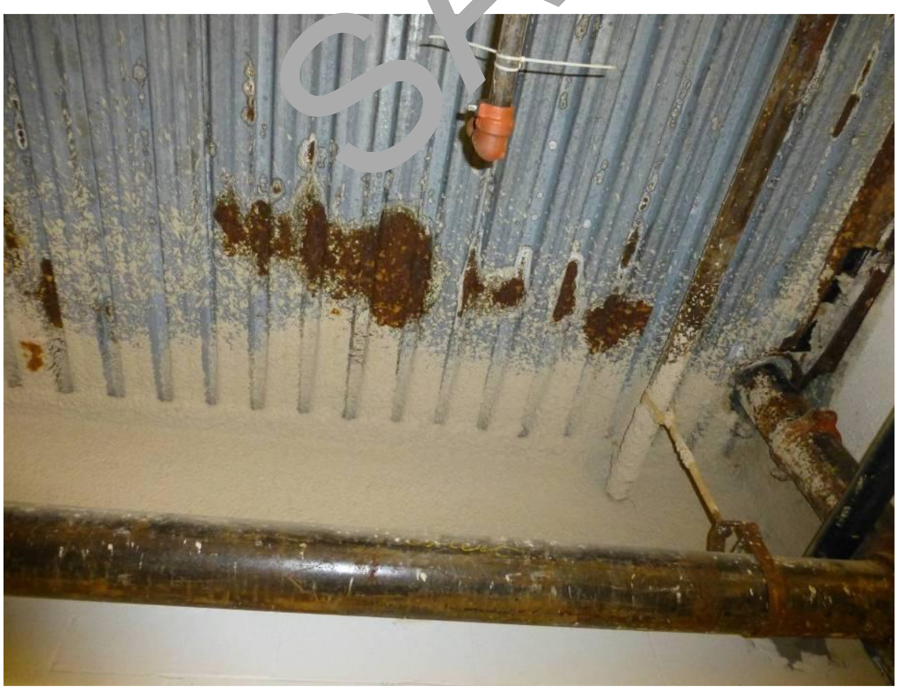
Photograph 15

View of some damaged steel floor deck in the first floor of the building.



Photograph 16

View of some stained and deteriorated metal floor deck.



Photograph 17

View of some stained and deteriorated metal floor deck.

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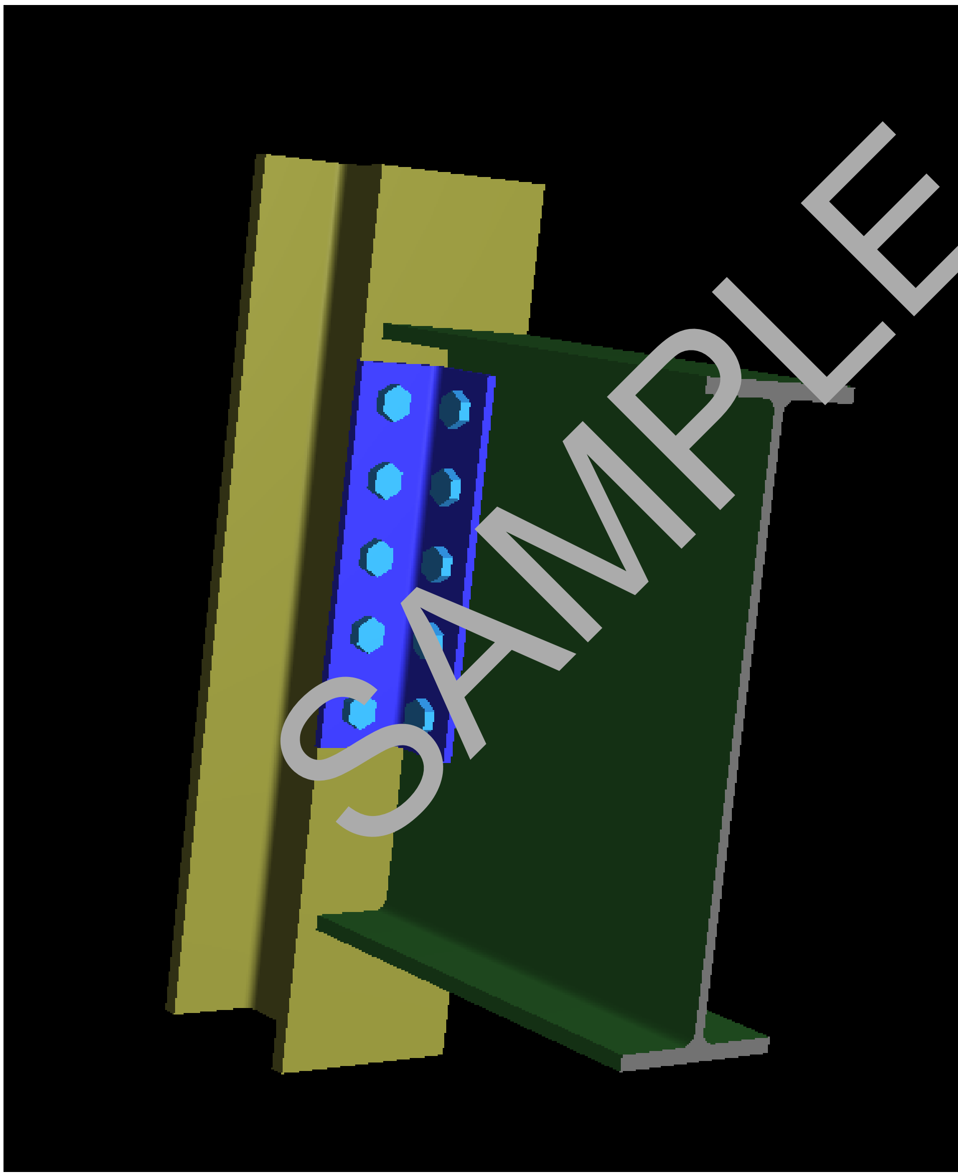
Calculations

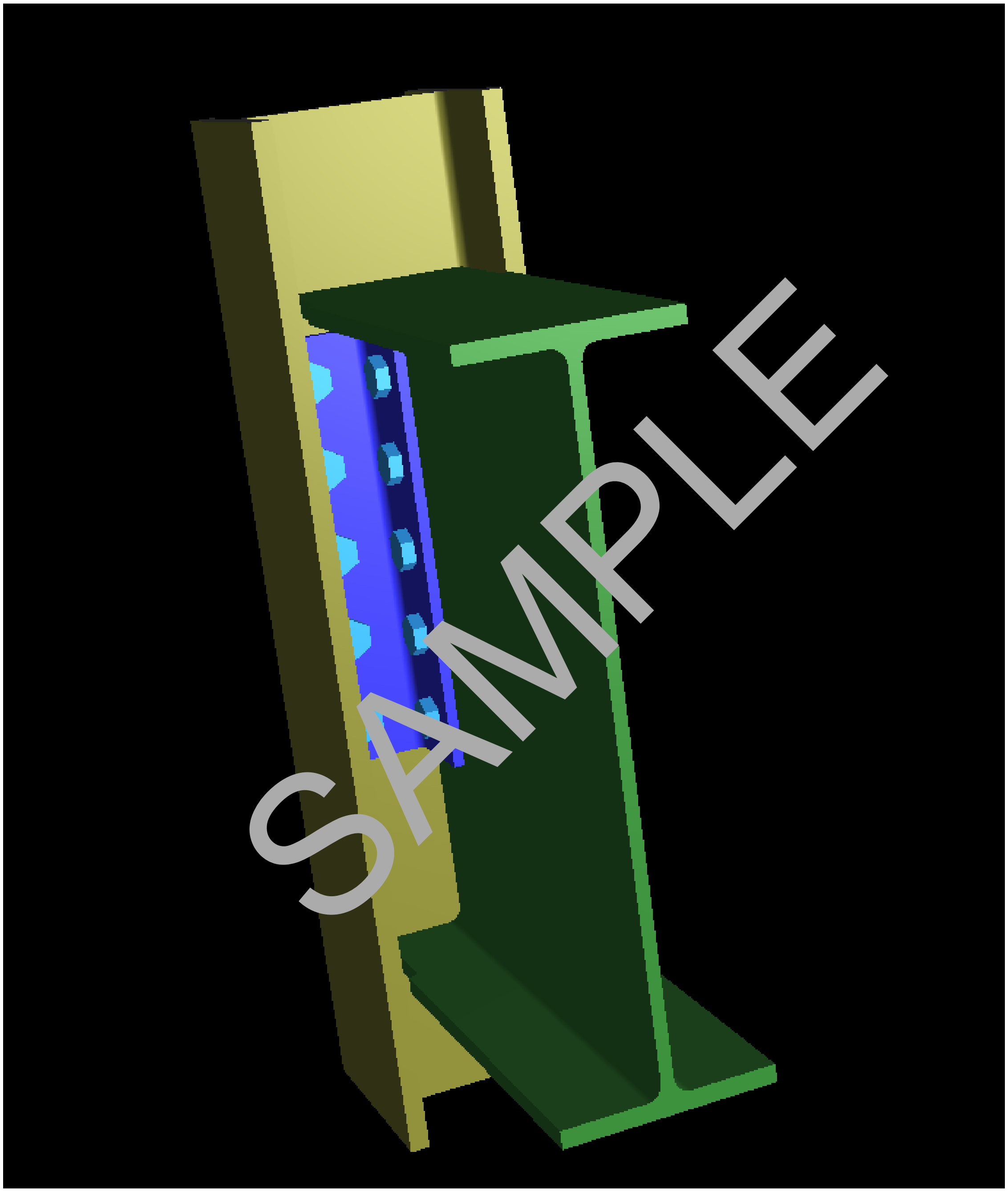
Connections

Typical connections:

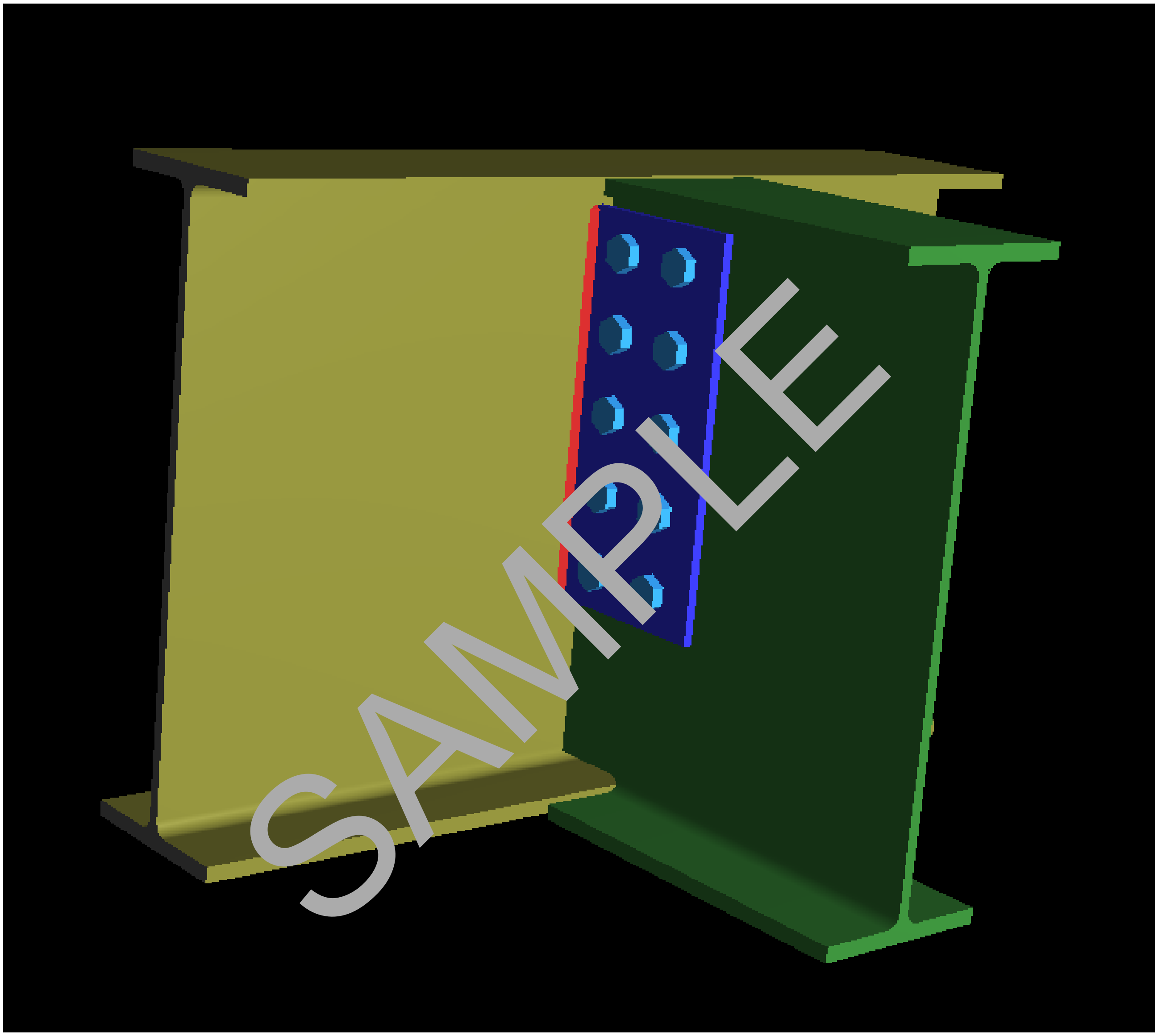
Beam-to-Column Flange



Beam-to-Column Web



Beam-to-Beam



Report Output

Slab-on-Grade

TM 5-809-12/AFM 88-3, Chap. 15

3-3. Stationary live loads.

Floor slabs on grade should have adequate structural live loads. Since floor slabs are designed for moving live loads, the design should be checked for stationary live loading conditions. Table 3-1 lists values for maximum stationary live loads on floor slabs. For very heavy stationary live loads, the floor slab thicknesses listed in table 3-1 will control the design. Table 3-1 was prepared using the equation

$$w = 257.876s \sqrt{\frac{kh}{E}} \qquad \text{(eq 3-1)}$$

where

- w = the maximum allowable distributed stationary live load, pounds per square foot
- s = the allowable extreme fiber stress in tension excluding shrinkage stress and is assumed to be equal to one-half the normal 28-day concrete flexural strength, pounds per square inch
- k = the modulus of subgrade reaction, pounds per cubic inch
- h = the slab thickness, inches
- E= the modulus of elasticity for the slab (assumed to equal 4.0 x 106 pounds per square inch)

The above equation may be used to find allowable loads for combinations of values of s, h, and knot given in table 3-1. Further safety may be obtained by reducing allowable extreme fiber stress to a smaller percentage of the concrete flexural strength have been presented by Grieb and Werner, Waddell, and Hammitt (see Bibl.). The selection of the modulus of subgrade reaction for use in table 3-1 is discussed in paragraph 4-2. The design should be examined for the possibility of differential settlements which could result from nonuniform subgrade support. Also, consideration of the effects of long-term overall settlement for stationary live loads may be necessary for compressible soils (see TM 5-818-1/AFM 88-3, Chap. 7).

FLEXURAL STRENGTH ASSUMED TO BE 5% OF COMPRESSIVE STRENGTH (3000 PSI) = 150 PSI

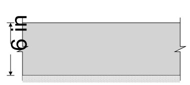
THEREFORE w = 237 PSF - THIS IS ULTIMATE LOAD SO REDUCE BY 1.6 = 148 PSF HOWEVER
<u>LIMIT TO 125 PSF</u>

WHEEL LOADS - AS FOLLOWS:

SLAB ON GROUND (ACI 360R)

In accordance with Guide to Design of Slab-on-Ground per ACI 360R-10

Tedds calculation version 1.0.00



Slab foundation-refer to Section 4.1 of ACI 360R

Design method

Design method publisher; **Portland Cement Association**

Materials and site properties

Slab thickness; $h = 6$ in

Specified compressive strength of concrete; $f'_c = 3000$ psi

Subgrade modulus; $k = 100$ lb/in^3

Wheel specifications

Axle type; **Single-axle**

Number of wheels at end of each axle; **Single wheel**

Wheel center to center spacing; $S = 32$ in

Loading details

Load location; **Interior**

Axle load; $P_a = 7.2$ kips

Safety factor; $FS = 2$

Load contact area per wheel; $A_c = 50$ in^2

By iteration assumend trial thickness; $h_{trial} = 5$ in

The following output is based on the use of this trial thickness in the design charts in Appendix A of ACI 360R

Effective contact area per wheel (Fig. A1.2); $A_{c\_eff} =$ [illegible]0.71 in^2

Slab thickness design

Modulus of rupture of concrete; $f_r = 9 \times \sqrt{(f'_c \times 1 \text{ psi})} = 493$ psi

Concrete working stress; $f_{t\_allow} = f_r / FS = 246.5$ psi

Slab stress / 1000 lb axle load; $f_t = f_{t\_allow} / (P_a / 1 \text{ kips}) = 34.2$ psi

Required slab thickness (Fig. A1.1); $h_{min} = 4.74$ in

$h_{min} / h = 0.791$

PASS - Slab thickness is adequate to avoid live load-induced cracks

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