Issues with Visitation in Historic Buildings and How to Solve Them

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Bennett Preservation Engineering PC

Structural Engineering for Historic Buildings

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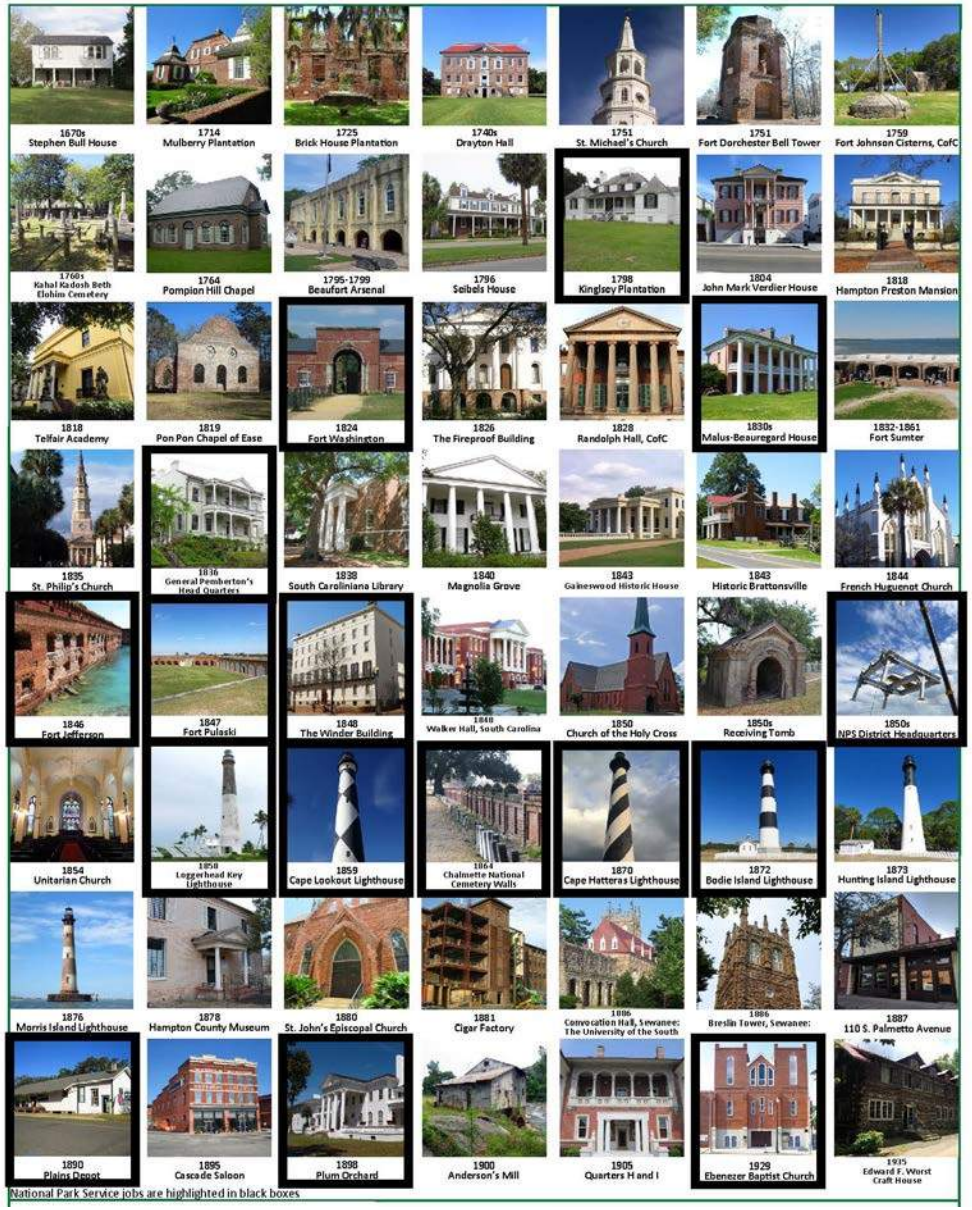
What We Do

We are a structural engineering firm that focuses exclusively on historic structures.

It is our job to evaluate and analyze historic buildings, and develop sensitive structural design solutions.



Visitation

- Introduction
- Visitors vs Buildings
  - Museums vs House Museums
- Common Problems
  - Fall Prevention
  - Fire Protection
  - Egress
  - Accessibility
  - Structural
    - Overloading
    - Handrails
    - Stairs
    - Vibration
- Code Issues
  - Change of Occupancy
- Case Studies

Case Studies

- Floor Loading
  - Drayton Hall (Great Room, Stair Hall)
  - SC Society Hall (Trimmer Joists)
  - St. James – Goose Creek (Balcony)
  - Telfair Academy (Floor Oculus)
  - Porches – a collection
- Stair Loading
  - Drayton Hall (again!)
  - SC Society Hall
  - Bodie Island Lighthouse
  - Hunting Island Lighthouse
- Handrails
  - Drayton Hall (again!!)
  - Fort Jefferson
  - Fort Pulaski
  - Fort Sumter

A Quick Poll

1. You are closely connected with, work for, or run a house museum or historic structure open to the public.

2. You are concerned about the number of visitors coming through.

- Bennett's Theorem
  - If you can keep the water out, you will solve your building's problems.
- The Corollary
  - If you keep the people out, you will solve your building's visitorship problems.

Visitors vs Buildings

Visitation issues are not limited to residential structures now open to the public.

Forts, churches, lighthouses and other unique buildings also have their share of challenges from visitorship that differs from their original purpose.

They were ALL designed for a specific use at the time of construction.

Visible Visitation Impacts

- Touching objects
- Leaning on walls
- Touching historic fabric/finishes
- Shakey handrail
- Picking at brick mortar
- Floor nails working loose

Invisible Visitation Impacts

- People standing in a tight group
- Overall group sizes
- Total quantity of visitors
- Fatigue of cyclical loading

International *Existing* Building Code - IEBC

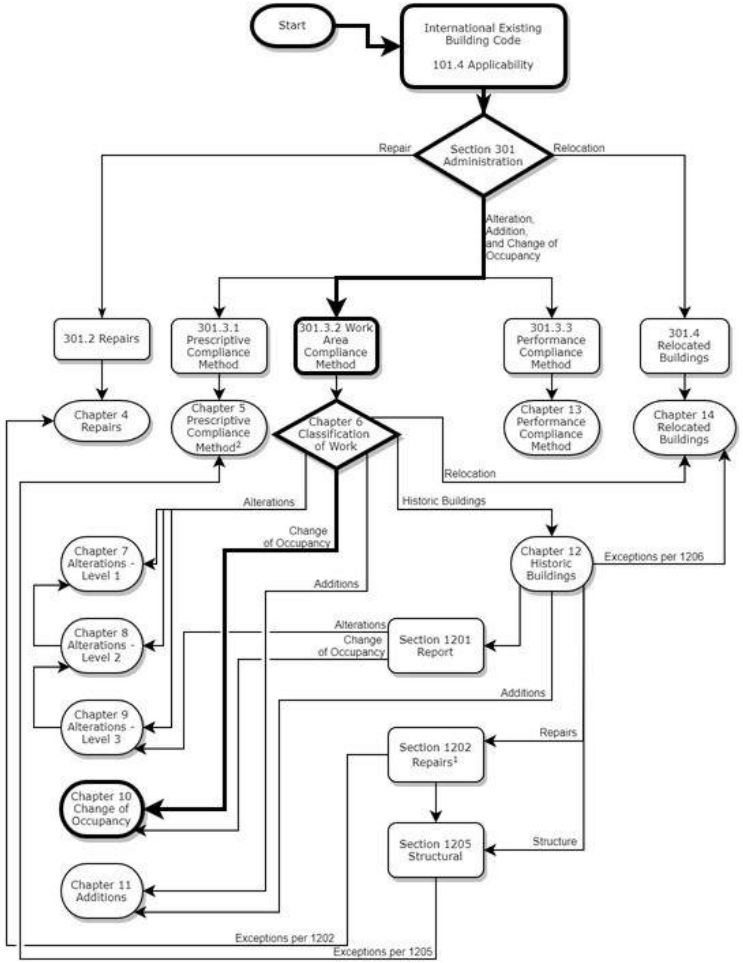
There are multiple routes through the various triggers in IEBC to get to the requirements for compliance.

Chapter 12 for Historic Buildings

1205.1 General
Historic buildings shall comply with the applicable structural provisions for the work as classified in Chapter 4 or 5.

Exceptions:

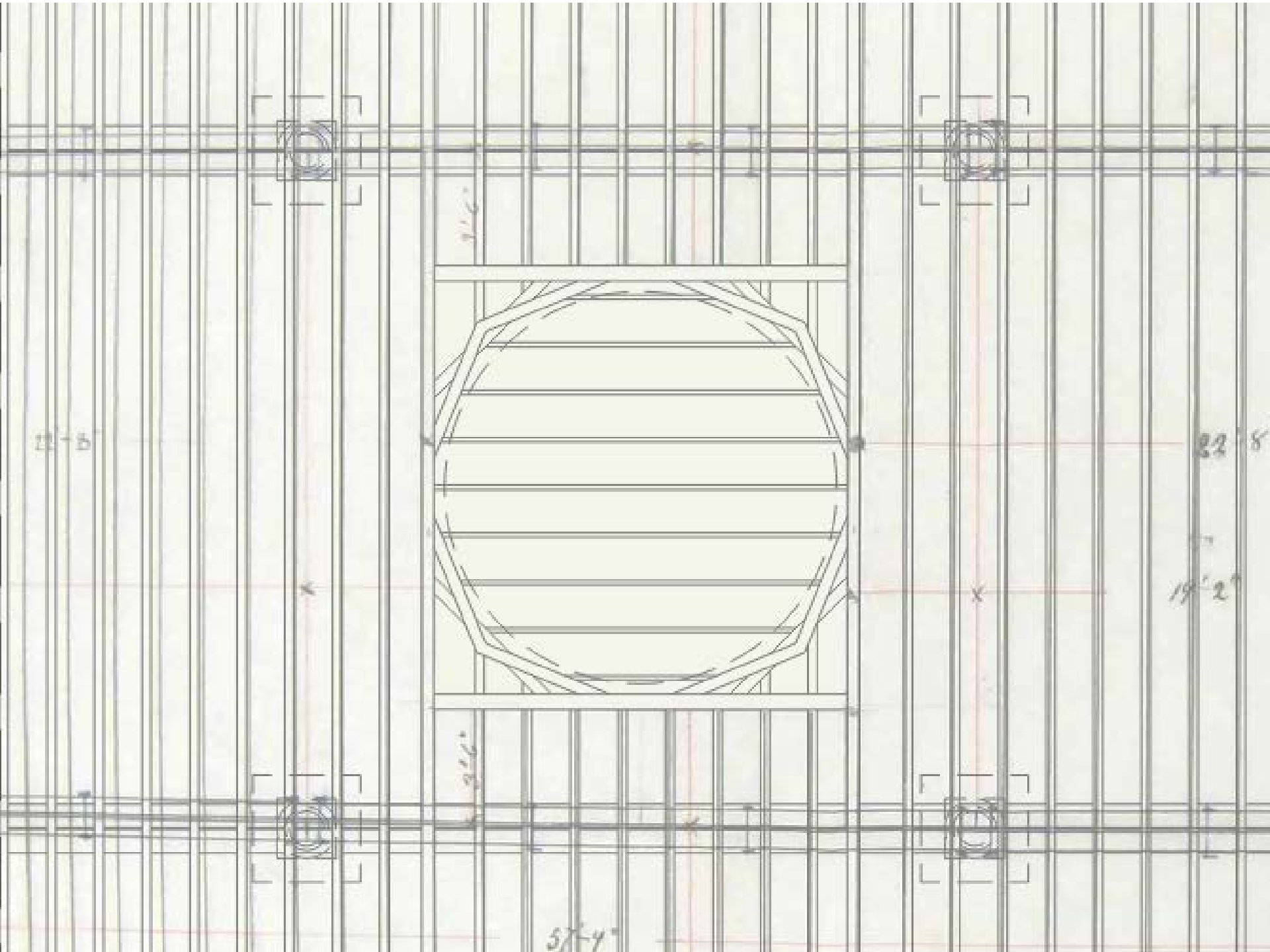
1. The code official shall be authorized to accept existing floor and existing live loads and to approve operational controls that limit the live load on any floor.

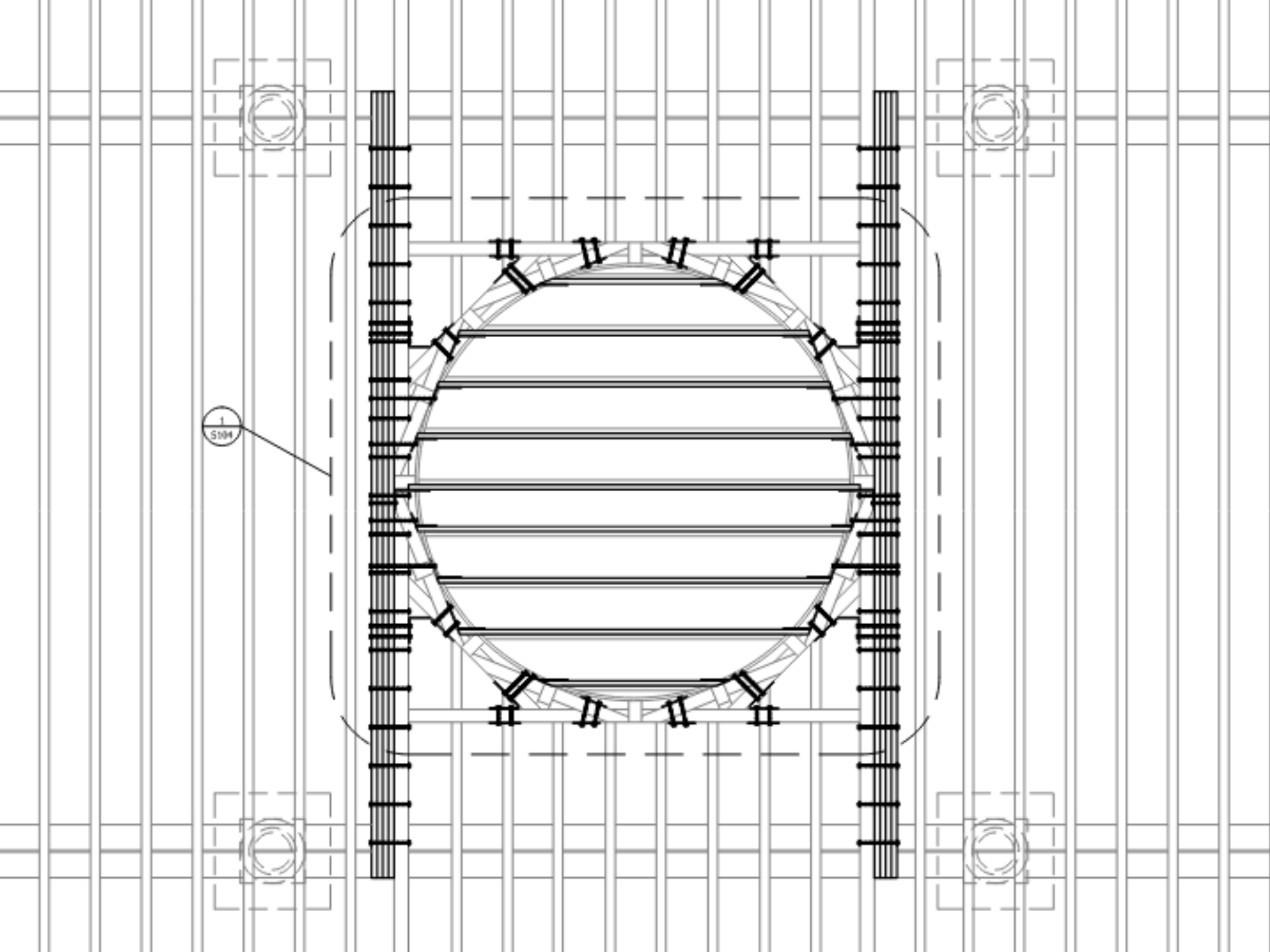


BOISE CASCADE VERSA-LAM 2.0-3100
2.0
2.0

B 2020
October 2

CAUTION
CAUTION




S1M4

Porches

Porches and balconies were not assembly spaces. A 2010 code change now ties the load to the adjacent space, to account for actual loading.

Frequently not designed for large loads.

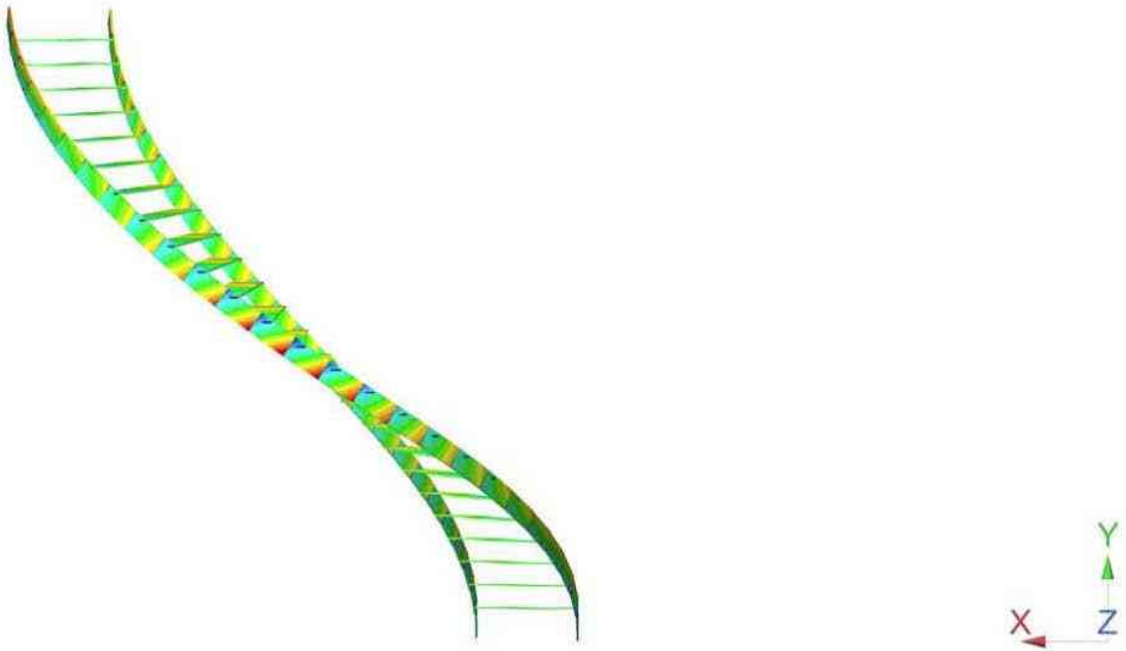
Purlins tend to be too small.
Girders tend to be deeply notched.
Connections tend to lack capacity.

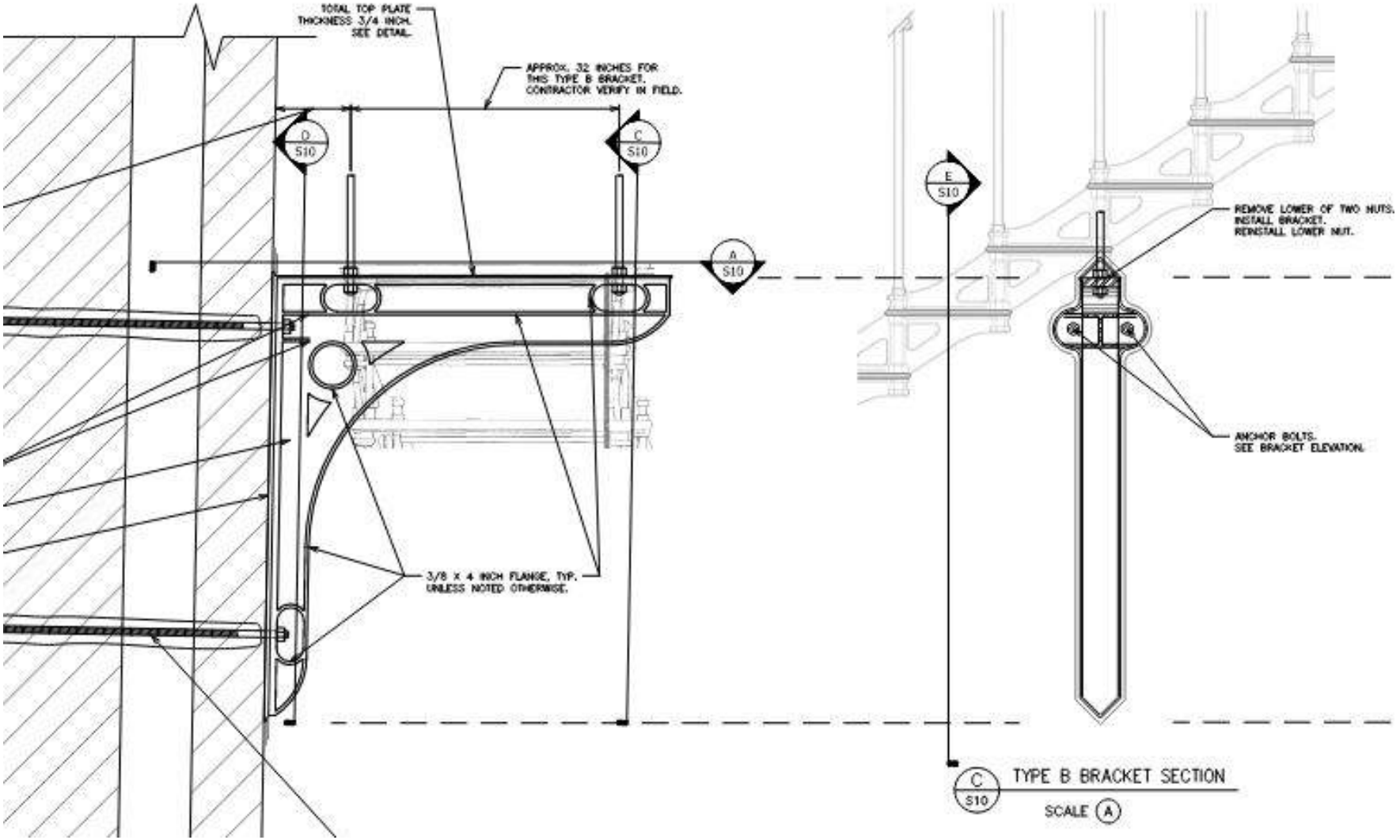
The Caroline and Albert Simons, Jr.
CENTER FOR HISTORIC PRESERVATION

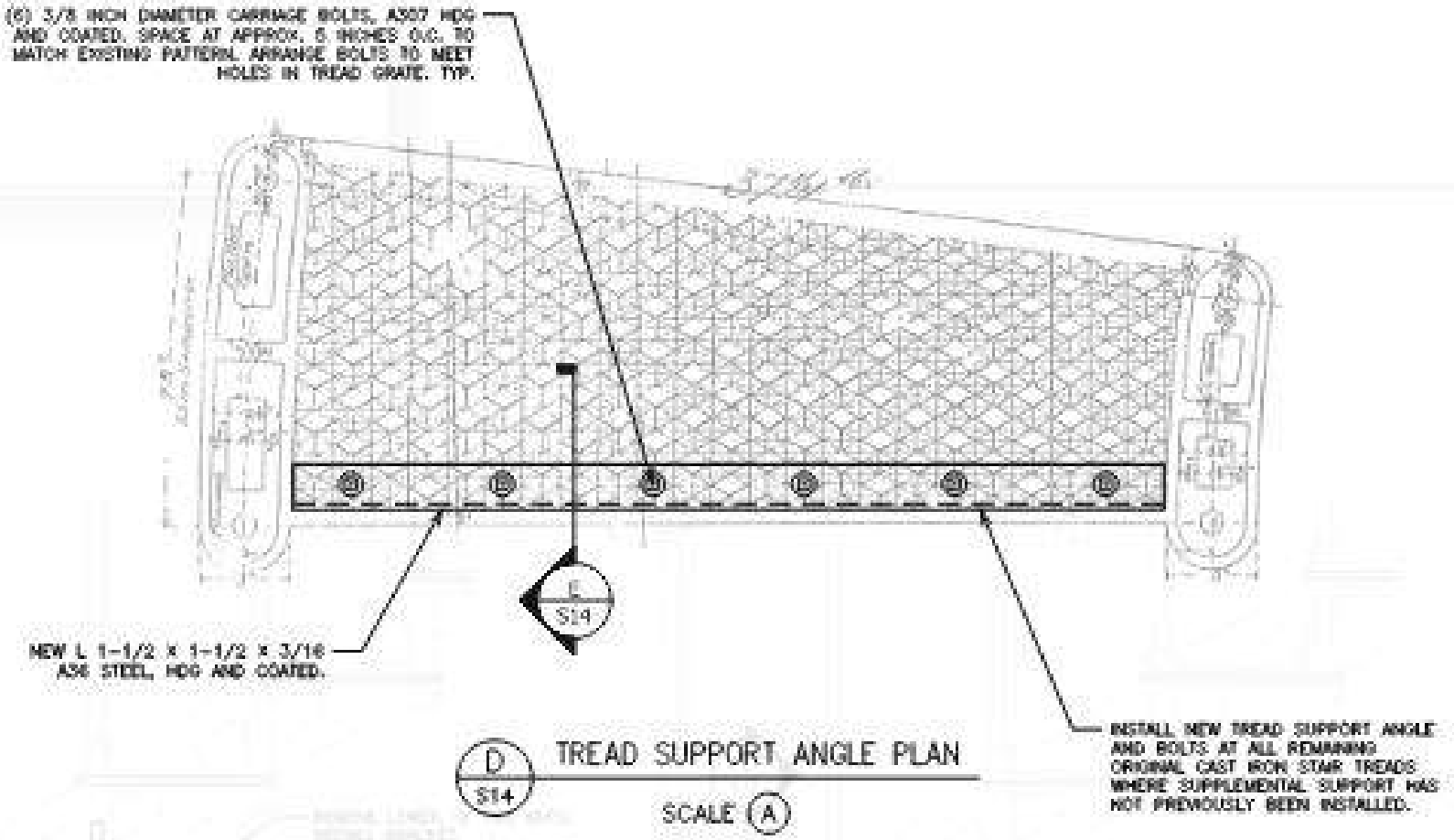
EXIT

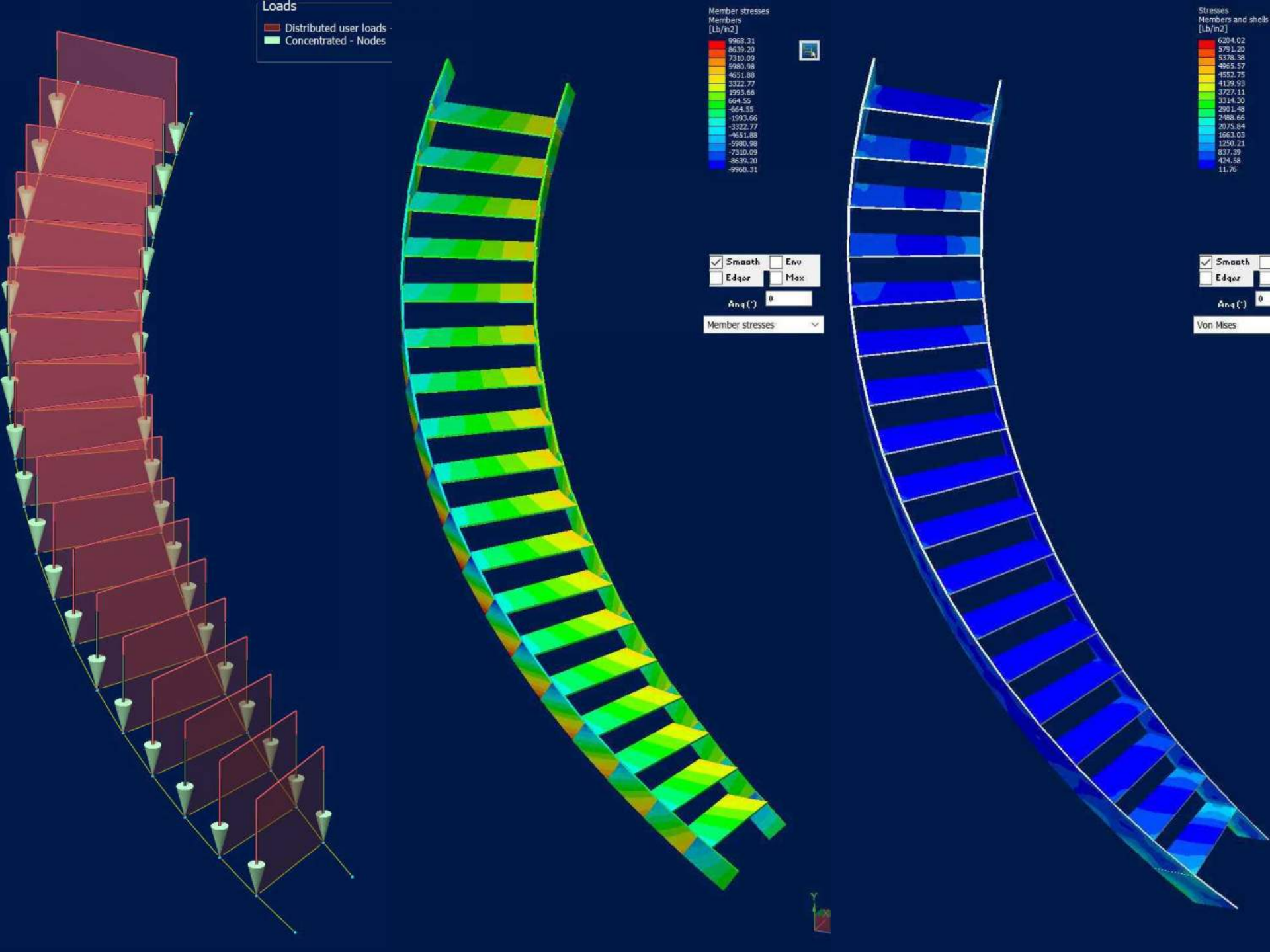
EXIT

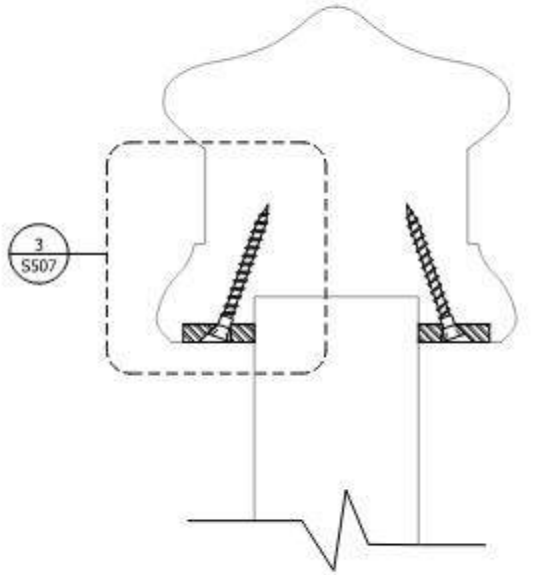
1st flight - 10th
Bottom
orignal step. Replac
2-19-08 Alex Klahn


Member stresse
Members
[Lb/in2]
4397.29
3810.99
3224.68
2638.38
2052.07
1465.76
879.46
293.15
-293.15
-879.46
-1465.76
-2052.07
-2638.38
-3224.68
-3810.99
-4397.29
Y
X
Z

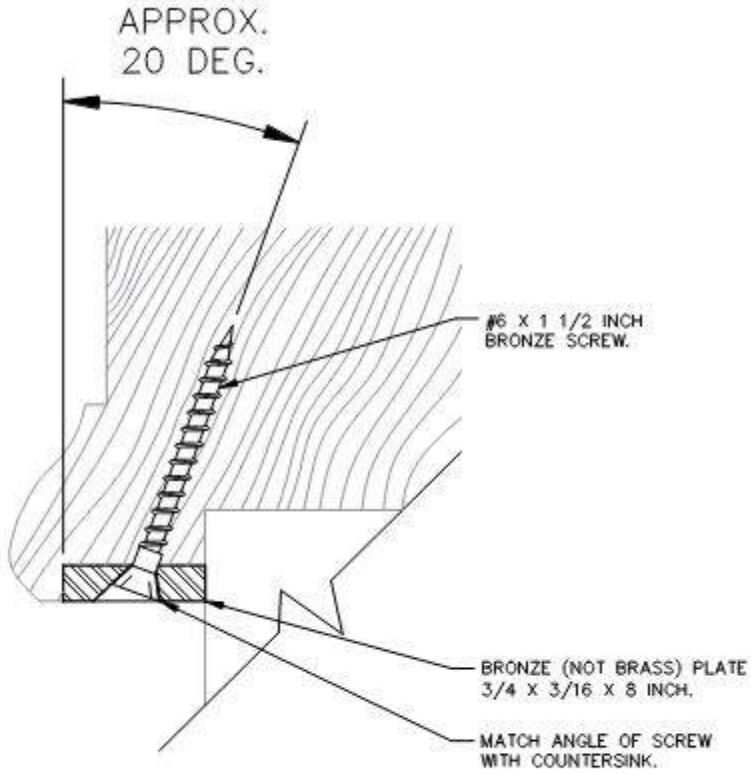

TOTAL TOP PLATE THICKNESS 3/4 INCH. SEE DETAIL.
APPROX. 32 INCHES FOR THIS TYPE B BRACKET. CONTRACTOR VERIFY IN FIELD.
D S10
C S10
A S10
E S10
REMOVE LOWER OF TWO NUTS. INSTALL BRACKET. REINSTALL LOWER NUT.
ANCHOR BOLTS. SEE BRACKET ELEVATION.
3/8 x 4 INCH FLANGE, TYP. UNLESS NOTED OTHERWISE.
C S10 TYPE B BRACKET SECTION
SCALE A


(6) 3/8 INCH DIAMETER CARRIAGE BOLTS, A307 HDG AND COATED. SPACE AT APPROX. 6 INCHES O.C. TO MATCH EXISTING PATTERN. ARRANGE BOLTS TO MEET HOLES IN TREAD GRATE. TYP.
NEW L 1-1/2 x 1-1/2 x 3/16 A36 STEEL, HDG AND COATED.
INSTALL NEW TREAD SUPPORT ANGLE AND BOLTS AT ALL REMAINING ORIGINAL CAST IRON STAIR TREADS WHERE SUPPLEMENTAL SUPPORT HAS NOT PREVIOUSLY BEEN INSTALLED.
D
S14
TREAD SUPPORT ANGLE PLAN
SCALE A


Loads
Distributed user loads
Concentrated - Nodes
Member stresses
Members
[Lb/in2]
9968.31
8639.20
7310.09
5980.98
4651.88
3322.77
1993.66
664.55
-664.55
-1993.66
-3322.77
-4651.88
-5980.98
-7310.09
-8639.20
-9968.31
Smooth
Env
Edges
Max
Ang(°)
0
Member stresses
Stresses
Members and shells
[Lb/in2]
6204.02
5791.20
5378.38
4965.57
4552.75
4139.93
3727.11
3314.30
2901.48
2488.66
2075.84
1663.03
1250.21
837.39
424.58
11.76
Smooth
Edges
Ang(°)
0
Von Mises



2 CONNECTION 2 SECTION



3 CONNECTION 2 DETAIL

DAY USE ONLY

CAUTION / CUIDADO
CAUTION / CUIDADO
CAUTION / CUIDADO
CAUTION / CUIDADO

Have We Scared You Yet?

Visitorship does impact the structure.

Historic buildings have unique challenges, but there is room in the code for unique solutions.

Common principles:

- Reduce the load.
- Reduce the span.
- Limit the number of people.
- Limit the number of people at a given time.

Questions?