“Virtual” Chair Deconstruction

ARCH 614
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Introduction

- **Purpose:** To take principles of static structural analysis and design and applying them to a real-world example.

- **Objectives:**
  - Virtually Model a real chair with its defined dimensions
  - Determine the design capacities of the chair based on its materials and connections
  - Add a realistic load to chair, trace the load through the chair’s structural members, & input into multi-frame 3D to analyze the chairs response to the added load
The Chair

- Manufacturer: IKEA
- Style: IVAR Dining Room Chair
- Construction Materials:
  - 2x2 No. 2 Dense (Assumed) Southern Pine
  - 5/8 Steel Screws (Assumed)
### Materials Analysis

**Design Capacities of Southern Pine:**
- Table of Dimensional Lumber 2” to 4” Thick, 2” & Wider
- Values in Pounds Per Square Inch (psi)

<table>
<thead>
<tr>
<th>Size</th>
<th>Grade</th>
<th>Extreme Fiber Stress in Bending $F_b$</th>
<th>Tension Parallel to Grain $F_t$</th>
<th>Horizontal Shear $F_v$</th>
<th>Compression Perpendicular to Grain $F_c$</th>
<th>Compression Parallel to Grain $F_{c'}$</th>
<th>Modulus of Elasticity $E$</th>
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<tbody>
<tr>
<td></td>
<td>Single Member</td>
<td>Repetitive Member</td>
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<tr>
<td>No.1</td>
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<td>2130</td>
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<td>175</td>
<td>565</td>
<td>1850</td>
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<td>1950</td>
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<td>980</td>
<td>175</td>
<td>565</td>
<td>975</td>
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</table>
Chair Structure

- Use of individual columns, beams, girders
- Top plate acts as bracing for live loads on the chair
- The top plate sits on the horizontal members to transfer loads to the columns which are then transferred to the ground.
Chair Assembly

- The individual structural members are brought together by simple butt joints.
- The outside columns are screwed into the interior girders & beams using 5/8 inch screws.
- The top seat plate is then screwed on top of the structural frame.
Load Analysis Problems

- **Assumed Load 1**
  - A 500 lb person applying a vertical (y-axis) point load in center of chair
  - No lateral (x-axis) force on assumed load 1

- **Assumed Load 2**
  - A 500 lb person seated normally applying a vertical (y-axis) point load of 333 lbs (2/3 of weight)
  - A lateral (x-axis) load of 167 lbs (1/3 of weight)
Load 1 Shear Results
Load 1 Moment Results
Load 1 Deflection Results
Load 2 Shear Results
Load 2 Moment Results
Load 2 Deflection Results
Conclusions

- Based on these findings, a 500 pound person does not come close to the capacity of the beam which leads us to assume that the connections would fail before the pine members would fail.

- In addition, the load capacities of the 5/8 screws would be able to handle the 500 lb load without any problems.
References

Works Consulted

IKEA USA and the Ivar Chair;

Southern Pine Design Values from the Southern Pine Council;
http://southernpine.com/designvalues1.shtml

Dixieline Probuild;
http://www.dixieline.com/woodjoint/woodjoints.html