IPRO 457-315
Design of a Large Scale Structure
IPRO 315 large scale structure Team

Faculty: Jamshid Muhammadi

Professional Consultant: Jie-Hua Shen
Research

- All research to date involves current automated automotive parking garage structures
- There are several similar projects both in the United States and Europe
- These projects utilize a variety of methods to lift the cars and place them in the parking racks
IPRO 315 Sub teams

- Architecture
- Architectural Engineering
- Structural Engineering
- Mechanical Engineering
- Transportation Engineering
- Cost Estimating
Structural Engineering
Step 1: Conceptualization

- **Necessary Features**
  - Small Footprint
  - Reliable Strength and Safety
  - Attractive Appearance

- **Options**
  - Reinforced Concrete vs. Steel Frame Structure
  - Automated vs. Self Park
Step 2: Design

- **Steel Frame Structure**
  - Allows for Compact, Efficient Design
  - Lateral Force System:
    - Braced Frame in N–S Direction and Moment Resisting Frame in E–W Direction
    - Allows for Clearance Necessary for Automated Parking System
  - Gives Structure “Industrial” Look
Step 3: Details

- **Braced and Moment Frame Details**
  - 3 Braced Frames on each side
  - Braced frame 1\textsuperscript{st} Floor (2L6 X 4 X \(\frac{1}{2}\)) 4\textsuperscript{th} floor (2L5 X 3 \(\frac{1}{2}\) X \(\frac{1}{2}\))
  - 1\textsuperscript{st} floor Center Columns (W14 X 61) – Moment Frame
  - 4\textsuperscript{th} floor Center Columns (W14 X 48) – Moment frame

- **Roofing Detail**
  - non composite deck 4.5 deep, 2.5” thick and weighs 45 psf.
  - Interior beam design
    - Beam - W16 X 57
    - Girder – W18 X 35
Design Model

Example of part of the structure computer model.
Mechanical Engineering
Outline

• Moving elevator structure, steel construction. Elevator moves on rails in conveyor aisle between parking spaces.
• Driver leaves vehicle at entrance, elevator picks up vehicle at entrance, transfers to vacant bay on desired level
• Elevator retrieves vehicle from bay, moves vehicle to ground level exit, driver picks up vehicle at exit
Research

• Types of elevator systems, hydraulic, pulley systems.
• Types of vehicle transfer systems; pallet system, roller system, comb system
• Research on sensor systems
• Research on elevator structure and construction
• Research on elevator components
Design and Calculation

- Elevator structure, total weight of moving structure
- Elevator platform design, pulley system and counterweight design
- Elevator-to-bay transfer mechanism design
- Structure movement mechanism
Parking Entrance Sensor Requirements

- Entrance must complete the following tasks:
  i. Check the vehicle dimensions.
  ii. Check if vehicle is correctly placed on elevator platform.
  iii. Check if anyone is in vehicle before parking.

- Requirements (i) and (ii) are met by using LTW’s system manufactured by SICK called the “Photo-eyes” system and infrared sensors.
  - Patron will be directed by light system.

- Requirement (iii) is met by using motion sensors.

- All systems routed to outside control box and user interface.
Elevator Structure
Elevator Platform
Architectural Engineering
LIGHTING DESIGN

Bay:
• Metal Halide
• 95 Watts

Aisle:
• Compact fluorescent
• 426 Watts

Outdoor:
• Metal Halide
• 465 Watts
Driving up to the garage

- 17.1 kW required to run lights

- A typical aisle

- Fluorescent lamps will last up to 20,000 hours. Metal halides up to 30,000 hours.
Site Design

- Site geometric redesign using programs such as Google Earth and Microstation.

(Pavement marking and traffic flow plans being created)
Average Annual Daily Traffic

Surrounding Streets of Site

- State Street    21,400
  about 15 cars/min
- 31st st.        16,200
  about 12 cars/min
- Michigan Ave.   16,300
  about 12 cars/min

Traffic conclusion:
Countermeasure studies show that lane widening or turn lane additions are not recommended because the garage won't affect traffic flow considerably. The existing lane conditions are more than adequate.
## Return of Green Area

<table>
<thead>
<tr>
<th>Description</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>New IIT Park</strong></td>
<td>51,000sf</td>
</tr>
<tr>
<td>(Existing pay lot west of track)</td>
<td></td>
</tr>
<tr>
<td><strong>Improved Landscaping</strong></td>
<td>41,000sf</td>
</tr>
<tr>
<td>(East of track, north, south, and east of garage driveway)</td>
<td></td>
</tr>
<tr>
<td><strong>Total Square Feet</strong></td>
<td>92,000sf</td>
</tr>
</tbody>
</table>

Existing conditions are at about 450 spaces.

Proposed garage is at 600 spaces.
Final Layout
References

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• http://www.inter-roller.com/Tower%20Park%20System.htm
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• LRFD Manual of Steel Construction, 3rd Edition