Activity 3.2.7 Keystone Library Floor Framing Design (Optional)

Introduction

During major renovation projects, especially when the building is old or will be used in a different way, it is often necessary to replace structural elements that do not meet current code requirements for the new usage. The industrial building that will become the Keystone Library was inspected by a structural engineer prior to the redesign effort. The final report on the existing building's condition indicates that the existing roof system was "designed for relatively light roof loads and will not support the new green roof or second floor of the library". Therefore, the engineer recommends that the framing be replaced with new structural steel framing.

It is common practice in engineering design for all design calculations and drawings to be checked by another engineer. In civil and structural design, a professional engineer who is licensed in the state in which the structure will be built must "stamp" design drawings, thereby taking legal responsibility for the design. However, any engineer, licensed or not, may have to defend themselves against a claim of negligence if work is found to be substandard. As an engineer, you should always have another engineer check you work, and you should ensure that the work of engineers working under your supervision is thoroughly checked.

In this activity you will use the knowledge you have gained to design the new structural steel floor framing for the Keystone Library Renovation Project. As a member of a design team, you will be assigned specific structural elements to design and then act as a checker of another team member's calculations.

Equipment

- Pencil
- Computer
- International Building Code
- Activity 3.2.4 Beam Analysis Short Cuts
- MD Solids software
- Composite Floor Deck Load-Span Table (distributed in Activity 3.1.6)
- Keystone 2nd Floor Framing Plan Composite Slab (distributed in Activity 3.1.6)
- Keystone Floor Framing Design Check Sheet

Procedure

Your team of two will design the second floor framing for the Keystone Library Renovation. Assume that the composite slab design from **Activity 3.1.6 Commercial Floor Systems** will be used. Therefore, refer to the **PRELIMINARY 2ND FLOOR FRAMING PLAN – COMPOSITE SLAB** drawing distributed in **Activity 3.1.6** for the floor framing layout.

Each member of the team will:

1. Perform the calculations necessary to design one beam and one girder for the new floor framing system. One team member will design the interior beam and interior girder. The other team member will design the exterior beam and exterior girder. You will need to share information in order to provide a cohesive design.
2. Check your teammate's calculations. Document your assessment on the **Keystone Floor Framing Design Check Sheet** and sign the form. As the checker, you assume responsibility that the design is adequate and meets code requirements.
3. Make necessary corrections to your calculations based on your teammate's assessment. Once you have made the necessary corrections and you both agree that the calculations are correct and that an adequate design has been selected, obtain your teammates signature on every page of your calculations.
4. Perform an MD Solids analysis to include shear, moment, slope, and total deflection (in inches) diagrams to verify the design selections for the beams that you designed.
5. Revise your Keystone Library Renovation 3D model to reflect your team's floor framing design. Tag the framing members to indicate the appropriate structural steel shapes. Note that the green roof elements will be chosen such that the same beams and girders will be sufficient to support the green roof; therefore, use the same framing system for the green roof members. This is a reasonable assumption since the live load for the green roof will be less (only 100 psf instead of 150 psf), allowing for an increase in dead load of up to 50 psf for green roof components and vegetation. This design will also allow the green roof to be enclosed and used for more stack storage in the future, if needed.

Criteria

The following data is to be used for design of the floor framing:

- Dead load will include the following:
  - Assume 10 psf for plumbing, electrical, mechanical, and fire suppression equipment loads (PEM).
  - Assume that the floor will support a suspended plaster ceiling with lath.
  - Assume lightweight concrete for the slab. Use the Composite Floor Load-Span Table to determine the dead load of the slab and metal deck.
  - The floor will be finished with ½ in. quarry tile.
  - Include 7 psf to account for the weight of the framing members.
- The floor will support library stacks. [Note: by inspection, the uniformly distributed load will control the design. Therefore, you are not required to perform calculations using the code-specified concentrated load.]
- Fy = 50,000 psi
- All beams and girders are continuously laterally braced.
- The beams on column lines will frame directly into the column and will not transfer

load to girders.

Deliverables

1. **Hand calculations** documenting the design of either interior beam/interior girder or exterior beam/exterior girder signed by a checker
2. A **Keystone Floor Framing Design Check Sheet** completed and signed by your teammate
3. Printouts of MD Solids analysis including shear, moment, slope, and total deflection diagrams to verify both your beam and girder design
4. A copy of your Keystone Library Renovation SECOND FLOOR FRAMING PLAN.

Conclusions

1. How would the Keystone Library floor framing design change if the hollow core floor system had been selected instead of the composite slab?

2. When would the internal shear force control the design?

3. What limiting factors could cause an engineer to choose a beam that is not the most cost effective structural steel section?