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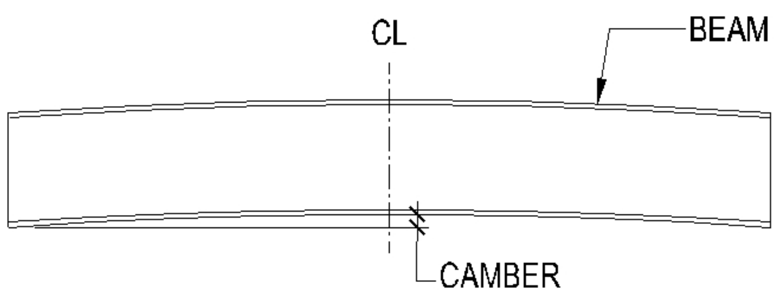
To Camber or Not to Camber?

Introduction

To compensate for deflections, structural steel beams and joists may be fabricated with a slight upward curvature, commonly referred to as camber.

Cambering

Cambering structural steel members is achieved by inducing residual stresses by means of cold or hot bending, with the former (cold) being the more common of the two. Cold bending involves placing the member in a press while hydraulic rams bear down on it producing a reasonably uniform curve. Hot bending is achieved through heating of wedge shaped segments at intervals along the span of the beam. The residual stresses associated with cambering do not affect the design strength of the member since such stresses are considered by the American Institute of Steel Construction (AISC) when developing their specifications.



Why Camber?

Specifying camber in beams can provide benefits to a project normally not realized without knowledge of camber. Such benefits include:

- **Efficiency:** Camber allows the engineer to specify smaller beam depths. This facilitates the running of ductwork, piping, electrical, etc. in between floors due to the smaller members taking up less space. This also maximizes floor to ceiling heights. These space efficient measures can lead to cost savings for the project in other areas such as cladding.

- **Materials:** Smaller beam sizes equate to reduced material costs.

Photo of beam cold cambering.

How much Camber?

There are certain restrictions for cambering of beams. As a rule of thumb, beams with the following criteria cannot be cambered:

- Beams less than 24 feet in length
- Beams in moment frames
- Beams shallower than 14 inches deep
- Beams with cantilevered ends

Additionally, the AISC specifies minimum and maximum camber values depending on the beam depth and span. For example, the minimum camber on a 24 inch deep wide flange beam spanning between 65 and 85 feet is 3 inches and the maximum is 5 inches.

Joist Camber

According to specifications set forth by the Steel Joist Institute (SJI), all joists are fabricated with a standardized camber based on joist span. Joist camber must be taken into account as it may affect adjacent framing members. The following are recent case studies illustrating the importance of coordinating deck supports when camber is involved:

- **Industrial Building:**
  At the roof of an industrial building we recently designed, we had steel beam moment frames at the columns and long-span joists parallel to the beams. The joists were cambered 2" per SJI requirements and the beams could not be cambered because they were in moment frames and had cantilevered ends. Even if the beams had been cambered, the span would have dictated a minimum camber of 3", which would not have matched the joists. Because of these structural limitations, the architect was required to adjust the roofing system to account for the elevation differences between the beams and joists.
- **School Gymnasium:**
  As is common in many school gymnasiums, and in several schools we recently designed, masonry walls are used to partition off various areas (i.e. storage, auxiliary gyms). This results in joists running parallel to the masonry walls. The camber in the joists can present problems if the masonry partition walls are used to support the metal deck (i.e. the wall cannot be built to adjust for the joist camber so adjustable deck supports must be added to the wall). We highly recommend that such walls are not used as part of roof support systems to avoid conflict and potential change orders.

Camber Measurement

At the present time, there is no reliable method to measure camber in the field. This is due to factors such as the deflection caused by the self-weight of the member, restraint caused by connections, and the release of stresses (or relaxation) within the member over time. As a result, measurement of camber can only be accurately performed in the fabrication shop while the member is still in its unstressed condition.

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