Centor Engineering Guide

Purpose

This guide is written for architects and builders, to give a general understanding of the structural engineering considerations that should be understood by those designing, specifying and building large openings. The guide is not exhaustive, but Centor hopes it will help those new to big openings.

For those with plenty of experience in this area, there will be little here that you do not already know; chances are you have experienced the downside of many of the situations described in this guide at some point in your career. If you have any insights that you are prepared to share with your fellow professionals, we would be very happy to hear from you so that we might include your learnings.

Loading and structural movements that cause few problems with regular sized door openings can have very significant consequences in a large opening. Your structural engineer will generally be able to ensure your building complies with all statutory regulations and does not fall down, but the movement of and around large openings often cause problems for the builder or the homeowner that can be easily avoided if planned for in advance.

Doors have some basic requirements, they need to;

- Open and close,
- Provide security and
- Keep the weather at bay.

But they also need to look good and feel good to operate, the threshold needs to be comfortable to walk on or over and they need to be simple to maintain. Consequently, the gaps between a door panel and its frames are often small and there is usually weatherstripping somewhere in those gaps as well.

To ensure that the doors remain trouble free for many years, it is important that the doorframe they operate in is stable. The door installer does his job early in the building program, often with many months until handover. If the building structure moves enough to stop the doors operating perfectly, then it is going to cost someone some money to put it right.

During the project build, rectifications can be simple enough, but after the job is complete, nobody wants to be called back to the house to fix things that no longer work. Callouts cost money and they can rapidly erode the goodwill established between the designer, builder and homeowner.

We hope you find the content useful and we would love to talk to you if you have a question or comment.

Deflection during construction

During construction, the progressive loading of the structure above the door needs to be considered, particularly in the situation where the head also supports upper floor and/or roof and wall loads.

The Centor door installation procedure has been designed to lessen the impacts of gravity load deflection by pre-cambering the head track during installation of the doors. The head track is generally set with an upward camber of 1/8” (3mm) from the horizontal. At this stage of the build, the load on the head will typically include the weight of all completed structure over such as framework and roofing and the weight of the doors if top-hung.

The upward pre-camber will then work to counter the additional loads applied afterwards, which typically include:

- Wall linings and siding/cladding
- Ceiling linings and insulation
- Upper flooring

Other superimposed dead loads including interior fit-out, furniture and heavy items such as spas, which may all contribute to long term deflection.

Wind load effects

The head and/or floor beams may be required to resist dynamic wind loads that will cause deflection of the beam upwards, downwards and laterally. With loading from large areas of walls and doors, these loads can be very high – equivalent in some cases to several tons of load. Lateral loads in particular can be significant if a floor or roof diaphragm is not able to be used to resist it and this load case should be considered early in the design by your structural engineer.

The head size required to limit gravity load and lateral wind pressure deflections will general be adequate to cater for loads such as wind uplift, however, each load case should be checked, particularly in the situation where large areas of wall, floor and/or roof are supported.

Wind load will also apply a twisting action on a header beam which must be resisted at the connection between header beam and posts and it is important that the junctions are appropriately designed.

Creep from sustained load on header beams

All building materials move as load is applied and removed, but some header materials move slowly and permanently under sustained loads that are below their yield stress, resulting in a permanent deflection. This process is called creep.

On small openings, the amount of creep generally does not cause any problems for the homeowner, but with wide openings, the amount of creep can and often does result in doors that no longer open and close properly. Sometimes a simple adjustment can remedy the situation, but occasionally the fix results in costs that are entirely disproportionate to the cost of avoiding the problem with good design.

The mechanism and extent of creep depends on the material used for the header beam. Both wood and concrete structural members are designed with long-term deflection as one of their design criteria because creep with both materials is an important factor. But how much creep is too much? *Any amount that causes serious problems* is the only useful answer, but as a rule of thumb keep to the smaller of the following two limits.

a. Total creep ≤ 1/8” (3.2mm)

b. Creep component of deflection ≤ span/2000

These limits are similar to that used for designing support structures for brittle masonry. For spans greater than about 12 feet (3.6 meters) wood beams become quite impractical. In many highly loaded situations, a 10 feet (3.05 meters) span is a good practical limit as appropriately designed beams become very deep for wider openings.

Steel beams are the practical answer for wide openings in wood framed construction just as they are in brittle masonry, for the simple reason that steel used within its elastic limits does not exhibit any creep at all. None! That is why steel has revolutionized the design of bridges and high-rise buildings in the last century. A well-designed steel beam appropriately connected to steel posts that run from floor structure to either the roof or sub-floor above makes a slim, stable structure that will not sag over time. Bolting wood trimmers under the beam and either side as well provides working surfaces that are friendly for conventional wood framing practices.

Connections between header beam and posts

There is a range of loads on the header beam that need to be resisted at the posts to prevent localized movement and a range of problems that any subsequent movement can cause including the cracking of internal and external wall materials at these corners. As well as the obvious dead load, there are also racking, twisting and uplift loads to be resisted.

Twisting loads are the ones that are most commonly overlooked. Wind load on the door head at the underside of the beam can impart a substantial twisting load, as can cantilevered loads as often experienced with folding doors and top hung sliding doors if they are fixed directly below the header. These twisting loads need to be resisted by a good connection to the posts or wall at either end.

With wood posts, always ensure that the header beam is well secured to continuous framing that runs through to the top plate. Bracket joints to both the top and bottom of the header are a good idea. A couple of long nails or screws into the end grain of a wood header beam are not usually sufficient.

When using steel posts, continue the posts past the beam, with the beam attached to the side of the posts, with welded or bolted joints at the top and bottom of the beam. Sitting the beam on top of a steel post may seem like a simple solution, but it makes stabilizing of this joint against lateral rotation difficult.