



Loadbearing Wall Removal

One of the most common interior renovation projects includes removing interior walls from a home to create a more open concept living space.

Of course, this is only possible if the walls are not load-bearing, or, if measures are taken by a structural engineer to replace the load-bearing wall with a new beam, or by strengthening the floor structure above that relies upon the load-bearing wall.

There is considerable confusion about the role of these interior walls, and it is important to carefully consider the implications of removing a wall, even when your Contractor assures you that it's ok. The following information will help to educate you about this type of renovation so that you can protect yourself and make wise decisions.

Please note that this document is not to be treated as a substitute for obtaining structural design and building permits that are normally required to alter the structure of a building.

Types of Load Bearing Walls:

- Wood frame stud walls: Typically made up from 2x4 or 2x6 wood studs spaced at 16" on center. These walls are commonly used in both interior and exterior walls in houses. (Note that most homes built after 1960 are wood frame construction with either exterior siding or brick veneer.)
- Concrete block masonry units (CMU's) are often called "cinderblock" masonry walls: Most commonly used as foundation walls in houses. Still commonly used today, especially when limited site access makes it difficult to place formwork for concrete construction.
- Brick masonry walls: Most commonly used as exterior, above grade walls in older homes (above grade, double wythe brick), but also sometimes found in older homes (below grade, in a triple-wythe brick configuration).
- Cast-in-place concrete walls: Most commonly used as foundation walls in houses, especially in new construction.

Interior walls may be load-bearing, meaning that these walls carry vertical loads from above and are required to provide proper support for the floor structure above.

Interior walls may also be simple partition walls, meaning that they don't provide support for loads from above but rather, simply serve as a separation wall between rooms.

Interior walls may also be shear-walls, meaning that they act as a diaphragm to provide lateral support for the building structure, to prevent the building from swaying sideways. Imagine a rectangular house which has windows across the entire front and rear walls and has no interior partitions which provide bracing for the side walls; in this case, the side walls of the house can be viewed as just flat plates with no perpendicular walls to provide rigidity, in which case the house can easily sway sideways under even moderate winds.

How do you identify whether a wall is a load bearing wall or a shear-wall?

If a wall directly supports the end of a floor joist, then the wall is clearly a load-bearing wall since the removal of the wall would remove support from the end of the floor joist.



However, in some cases, even when the joists are continuous across the top of the wall and don't directly support the end of a joist, the wall can still be load-bearing since removal of the wall will render it over-spanned. ("over-spanned" meaning that, by removing the wall, the floor joists span over a distance that exceeds what is allowed by the building code).

The only way to determine whether the floor joists are continuous or discontinuous above a wall in a finished home is to cut a hole in the ceiling and examine the joists. You or your contractor can cut a hole in the ceiling and look inside the ceiling to determine whether the joists are continuous or not. Be careful not to cut any wires or pipes! Always use insured trades.

The joists above the wall are continuous...does this mean that the wall is not load-bearing?

Sometimes floor joists are observed to span continuously over top of a wall; in this case, the wall still may be load-bearing. The only way to know for sure is to check to see if the overall span of the floor joists is less than or equal to the maximum allowable floor joists span provided for in the local Building Code. For example, Part 9 of the Ontario Building Code requires that the maximum allowable clear span of a 2"x8" (usually measures 1.5" x 7.25") is only 11'-9", so if the span is greater than 11'-9", then the joists are deemed to be over-spanned if you remove the wall.

It is also important to note that just because there is no underlying support beam below or near to the wall to be removed does that mean that the wall is not load-bearing. The point to remember is that any wall that is located under a series of floor joists DOES provide some amount of support, and by reducing the amount of support under a wall always necessitates professional evaluation of whether the wall removal has reduced the strength of stiffness of the floor system above.

In many older homes which are long and narrow, the main floor (1st floor) joists span the full width of the house with no intermediate support beam, but the 1st floor joists still provide support for the wood frame stud wall above (often located between a hallway and a living/dining room) which provides support for the second floor joists. The 2nd floor joists may be continuous above the wall but are over-spanned if the wall were to be removed. As such, they rely upon the additional support provided by the wall, without which, the 2nd floor joists are rendered over spanned. We have coined the term "load sharing walls" for this type of structural arrangement, since these walls have the effect of tying the continuous main floor joists to the continuous second floor joists above. When one of these walls is removed, the main floor joists receive less load than before, however the 2nd floor joists suffer from the loss of the support wall from below, rendering the 2nd floor joists both overloaded and overly flexible (bouncy).

How can a floor be strengthened to compensate for the removal of a load bearing wall?

If the wall that you want to remove is load bearing, then you will need to do one of the following to provide support for the floor above:

1. **Introduce Beams:** A beam (wood or steel) can be designed and installed to replace a load-bearing wall. The new beam should be properly sized by a structural engineer or other competent home designer and must be properly supported at each end on properly designed posts and footings, or, on load-bearing support walls.

The new beam can be either "flush" mounted (embedded into the floor cavity above) or "dropped" below the ceiling, leaving a bulkhead.

When the beam needs to be small and compact, then steel is the preferred choice of material. As a general rule of thumb, a steel beam will need to have a depth approximately equal to the length of the beam, divided by 24, whereas a wood beam will need to have a depth approximately equal to the length of the beam, divided by 17. These sizes should only be used as a general guideline; the type and grade of lumber, number of plies, and steel flange thicknesses will vary depending upon the actual loads which need to be carried and detailed design of these beams and supporting posts by a structural engineer is always needed.

In some situations, a completely open concept is required where even new posts cannot be accommodated within the desired layout. In this situation, it is sometimes possible to support the ends of new beams on

transfer beams oriented perpendicular to the new beam so that loads can be transferred to the exterior walls of the home at the level of the beam, and no new posts are required. Note that this sort of arrangement adds extra beams (and therefore extra cost) to the project.

2. **Strengthen Floor Joists:** If floor joists will become over spanned due to the removal of a load-bearing wall, then it may be possible to strengthen each and every floor joist by glueing and nailing new joists to the sides of the existing joists, so that the new strengthened joists meet building code requirements to span the full distance. Usually this is only done when the original floor joists are continuous and in good condition, and when loads from above are generally uniform. Sometimes the new strengthening joists are larger than the existing joists, resulting in a slight loss of headroom below the area of the new joists.

Where the wall to be removed is near to or beside a stairway opening (which is very often the case) then strengthening of the stairway header and trimmer joists is usually also required, and strengthening of these components usually requires the temporary support of the floor joists while the header and trimmer joists are strengthened or replaced entirely with stronger members.

In the region where a load bearing wall is to be removed, it is possible that this wall contains within it a post that provides support for some other structures from above; in this case, a new transfer beam may *also* be needed locally to pick-up this point load from above. The presence of loads from above is one of the reasons that it is important to measure-up the entire house so that a proper evaluation of all likely loading scenarios can be evaluated.

One of the difficulties in strengthening floor joists is that, to do so, electrical wiring and heating system ducts or pipes often need to be removed and/or relocated, and this can add significant additional cost the project.

It is very important to have your engineer review all site conditions with this in mind when strengthening of individual floor joists is the proposed solution to removing a load-bearing wall.

How is my structure supported?

All building structures must be supported on footings or foundation walls which are designed to carry the weight of the structures above. The basement foundation wall of a house must resist soil pressure from the outside, and also must be able to support loads from walls, beams, and posts from above. Interior walls of houses are, therefore, sometimes structural insofar as they provide support for floor joists, roof joists, and ceiling joists from above.

How much does it cost to remove a wall and install a new beam?

The cost of removing and disposing of a wall and supplying and installing a new beam will vary tremendously depending upon the size and length of the beam and the ease with which electrical and heating system can be relocated. The only way to fully determine the total cost is to have design drawings prepared by a structural engineer so that you can obtain apples-to-apples quotes from several contractors. Ideally, you should also budget certain fees for electrical, heating, dry walling, painting, and floor repairs. It is also important to remember that in some situations, new support posts need to be installed, and these posts sometimes need to extend all the way to a basement floor where new concrete footings need to be installed; alternatively, new posts can be supported on existing floor beams which may or may not need strengthening to carry the new concentrated point load from the new posts.

Without having any detailed information about your project, we recommend that you budget \$8,000 to \$10,000 per wall which is to be removed.

I want to create an entirely open concept with a full wall of doors and windows at the back of my home...is this possible?

It is possible to create an entire wall of windows and doors, however, remember that door and windows are not like walls...they can't be used to support vertical or horizontal loads (horizontal loads are from wind forces and earthquake

forces). For this reason, it is often necessary to introduce not only steel beams (to carry vertical loads) but also steel columns which are rigidly connected to steel beams below and above the window and door openings.

Are these steel beams and posts what my engineer called a shear frame or moment frame?

Yes, a shear frame (sometimes called a moment frame) is designed to frame around an opening but be extremely rigid so as to prevent inter-storey drift between two floor levels. The steel frame is made of steel since it must be very rigid, and it is almost impossible to achieve the required rigidity with wood or engineered wood products. The steel shear frame must be fastened very thoroughly to the floor framing both above and below the opening where it is to be provided to be effective.

There are also some proprietary engineered wall systems available on the market which can be used to strengthen the walls beside a new wall opening, to achieve a similar result, however these systems still require input from a structural engineer.

Is a shear frame expensive?

Sometimes a shear frame can add quite a bit of cost, as much as \$8,000 to \$15,000 to the cost of the house framing, depending upon the size of the opening. Make sure that you have this kind of frame designed by a professional structural engineer and installed by a contractor who is familiar with this sort of construction since the detailing of this frame is important. We also recommend that you have the installation inspected carefully at the time of construction since improper installation will defeat the whole purpose of the frame itself!

I'm moving into a house in the middle of June and would like to remove a wall on the main level and 1 post in the basement if possible.

- What information do you need?

Based upon the size and extent of work that you are planning, we can often prepare a proposal for design services without first coming to the house. If you decide to hire us, we will send you a request for retainer, and then we will come to the house and take detailed measurements on each floor level, to prepare measured plans for the house suitable for making a building permit application.

- What do your services cost?

The cost varies depending upon the size of the house to be measured, and the extent of structural work required. We typically work on a fixed fee basis to prepare design drawings for your project, and we charge for site visits on an as-needed basis.

- Do you need to visit the house?

Yes, we will need to take site measurements of the house to prepare drawings, and later to carry out site reviews to ensure that the work is carried out in accordance with our design.

- How long does it take to do all the calculations?

Usually, we are able to deliver our design within about 3 weeks of being hired. Rush jobs can sometimes be accommodated. Permits typically take about 3 weeks to obtain once the permit application has been submitted.

- Can an engineered wood beam be used instead of a metal I-beam?

Yes, usually engineered wood beams (LVL beams) can be used instead of using steel beams, except when beams need to support masonry construction, when steel is needed.

Please call us!

If you would like us to help you with your renovation project, please call us and we can provide a quotation for the preparation of detailed design drawings that you will need to apply for and obtain a building permit from your municipality.



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