



# GUIDE TO STRUCTURAL ENGINEERING SERVICES FOR ONE- AND TWO- FAMILY RESIDENTIAL STRUCTURES

Prepared by:

**Boston Association of  
Structural Engineers  
(BASE)**



This Guide was prepared by a committee of the Boston Association of Structural Engineers (BASE). The purpose is to clarify the intent of the building codes with respect to who should be looked to for the provision of structural design for residential construction. More specifically, it is intended to inform homeowners, home builders and renovators, building inspectors, home designers, Architects and others involved with residential construction as to when and why a Structural Engineer may be required or recommended. This Guide is based on the many years of experience and resulting opinions regarding the structural engineering of residential structures by individuals from within the structural engineering profession in the Greater Boston area. Members of the committee consisted of the following (Note: "PE" signifies "Professional Engineer"):

Co-chairmen:

Val Prest, PE and Arthur LeBrasseur, PE

Committee:

William Barry, PE

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**Residential structures** (for the purpose of this guide) are one-and two-family homes, including associated accessory buildings (e.g. sheds, detached garages, swimming pool enclosures, non-agricultural-use barns) or any other structure that serves the use of the home.

**The Building Code** states that any residential building for which the structural design is not prescriptive or whose structure is so unconventional as to be determined by the local building permitting authority to fall outside the limits of the building code, requires professional structural engineering services.

**Prescriptive** means that something is capable of being determined using the tables and other information in the building code.

**A Professional Structural Engineer** (for the purposes of this guide) is an individual who is qualified by education, by experience, and by having obtained professional registration or licensure as a Structural Engineer (also as Civil or Professional Engineer practicing as a Structural Engineer) in the state(s) in which he or she practices, to provide structural engineering services for residential buildings. Structural Engineers provide analysis and design of structures, using appropriate code-mandated, applied loads and material properties.

**A Professional Architect** (for the purposes of this guide) is an individual who is qualified by education, by experience, and by having obtained professional registration or licensure as an Architect in the jurisdiction (e.g. Commonwealth of Massachusetts) in which he or she practices, to provide architectural design services for residential buildings.

**Who might engage the services of a Structural Engineer?** (for the purposes of this Guide) A homeowner, home designer, licensed contractor or Architect are those most likely to engage the services of a Structural Engineer for residential construction projects.

## **SITUATIONS THAT MAY NECESSITATE STRUCTURAL ENGINEERING SERVICES:**

(Assuming no conversion to other uses such as retail, business or storage)

### **EXISTING RESIDENTIAL STRUCTURES:**

The homeowner, designer or contractor wants to:

1. Remove or re-locate columns or bearing walls.
2. Determine if walls intended to be removed or modified are load bearing.
3. Increase the sizes of rooms or build new additions.
4. Remove or alter ceilings, particularly ceiling joists below roofs.
5. Add one or more floors (levels) or additional loads to the house or structure.
6. Alter a roof (such as adding shed dormers, window dormers or changing its geometry).
7. Convert attic space into living space under some conditions.
8. Alter a foundation (lower a basement floor, cut openings through foundation walls, etc.).
9. Create openings through existing bearing walls, floors and roofs.
10. Reduce floor bounce or sag.
11. Stiffen floors for additional loads (such as tiled floors, hot tubs, heavy furniture, islands, etc.).
12. Modify the house in a way that reduces resistance to wind and other lateral loads.
13. Determine the cause of structural damage and flaws, such as cracks, sags, bulges, etc.
14. Design repairs for structural damage and flaws.
15. Evaluate or design retaining walls (walls that retain four or more feet of soil).
16. Modify the structure in consideration of flood hazard.
17. Evaluate damage and/or deterioration due to floods, fires and other disasters.
18. Evaluate and/or design exterior decks, porches, balconies and their stairways, ramps and railings.
19. Evaluate fire escapes and stairs.
20. Evaluate chimneys.

## **SITUATIONS THAT MAY NECESSITATE STRUCTURAL ENGINEERING SERVICES (continued):**

(Assuming no conversion to other uses such as retail, business or storage)

### **NEW RESIDENTIAL STRUCTURES AND ADDITIONS:**

Retain a Licensed Structural Engineer to propose and/or specify appropriate structural materials for safety, code compliance and economy. It is strongly advisable to request structural engineering services when the proposed structure is to have:

1. Large clear span rooms like great rooms or open-space layouts in living areas or basement.
2. Complex roof and floor layouts (including roof gardens and floors at different levels).
3. Roof trusses (wood or steel).
4. Large openings in bearing walls.
5. Cathedral or high vaulted ceilings.
6. Wall systems greater than ten feet high.
7. Foundation walls that do not meet the prescriptive requirements.
8. Concrete components and/or systems other than conventional foundations.
9. Structural steel components and/or systems.
10. Engineered lumber (such as laminated members, I-joists, etc.).
11. Timber beams.
12. Exterior elevated decks, porches, balconies and their stairways, ramps and railings.
13. Retaining walls.
14. Elevators or lifts.

## QUESTIONS AND ANSWERS

### *Should I hire a structural engineer to design my home?*

Yes, if various elements of the framing might not conform with the limitations of the prescriptive provisions of the building code, or if you simply want a Structural Engineer acting on your behalf. Architects and home designers generally do not have the skills needed for designing structural systems beyond that which is tabulated in the building code. Hiring a structural engineer will give you access to a specialist focused on the structural design who will provide optimal and economical structural solutions based on sound engineering principles.

Though preferred for high-end and complex residential construction, architects and structural engineers are not always required by law to design residential structures. Licensed architects and structural engineers are needed when the home exceeds the prescriptive (tabulated) architectural and/or structural requirements of the building code (i.e., structural engineers for items discussed herein and architects for egress, fire ratings, special doors, windows, roofing, etc.). Homeowners, unlicensed home designers and anyone else are allowed to determine the framing for residential structures as long as they fall within the limits of the prescriptive requirements of the building code. In some cases a homeowner may already have a framing layout and only needs certain aspects of the framing designed by a structural engineer to complete the drawings for their new home or renovation.

### *Can my architect design my structure?*

Yes, within the limits set by the building code, architects are permitted to design residential structures. Architects, however, are generally not specifically trained to perform structural engineering. Some architects have gained enough experience to be competent in designing residential structures. You will need to check with your architect about his/her structural framing knowledge.

## QUESTIONS AND ANSWERS (continued)

### *My lumber supplier has offered to provide me with stamped structural drawings for my project. Should I save the money on an engineer and use the lumber yard services?*

Generally no, because the lumber yards only provide engineering for engineered lumber as part of their package for selling lumber. For this reason they disclaim responsibility for the rest of the structure. Your best option is to hire an independent engineer. Keep in mind that he/she will be responsible for the overall building design, but will likely still utilize the specialty engineering offered by the lumber yards where appropriate.

Lumber yards typically provide floor designs, tall wall designs, truss designs or other parts of a structure. They do not however, provide design for the building as a whole. For example, a manufacturer or supplier of lumber may provide you with the entire floor framing system and prefabricated floor or roof trusses. What they usually do not provide is engineering for the foundations, lateral loads (such as wind loads) and materials other than engineered wood products. They also generally do not provide engineering for the vertical framing elements (walls and posts). They provide engineering for engineered lumber as part of their package for selling lumber. This limits the type of material options available to the buyer. Also, this piecemeal approach may not provide the best economy overall, and it can lead to errors. For instance, a lumber yard's designer may overlook the fact that the truss or beam he/she is designing needs to support a load from some part of the structure that is designed by someone else. This problem is exacerbated when the design is only based on partial information about the building provided by the homeowner or contractor. For this reason, designs by lumber yards generally have extensive disclaimers on their drawings and calculations that they hope will exclude them from liability. Finally, lumber yards generally do not provide inspection services for the entire structure and do not "sign off" on the entire structure for the building department.

This does not mean that the expertise of an engineer specializing in some product cannot be used wisely. A better approach is for a structural engineer to work on the entire project. This engineer is then known as the Structural Engineer of Record (SER). The SER then specifies the design parameters for the lumber yard's or manufacturer's engineer, who would then design and stamp those parts of the structure. As an additional check, the SER should review the calculations and/or the "shop drawings" produced by the specialty engineer, to ensure that the design parameters were interpreted correctly.

## QUESTIONS AND ANSWERS (continued)

***If my contractor tells me that they always “over-build” their structures, would I still want to engage an engineer?***

Yes. It is important to realize that the functions and background of a contractor and an engineer are different. The contractor builds the structure based on a design that was either provided to them or determined directly from the building code. An engineer comes with a different set of skills. They design a structure based on a multitude of loading conditions and materials with differing structural properties.

A contractor often works from experience based on something they believe to have worked in the past. A contractor may know that to resist a higher load, they need a larger beam, but may not be able to properly size the beam and connections. Larger members and stronger materials do not necessarily mean the structure is more stable as structural stability is a concept misunderstood by many contractors.

An engineer is trained to understand the behavior of a wide range of different materials and to predict how that behavior will change under loading and environmental conditions. He/she is trained to consider complete load paths, and the integrity and stability of the overall structure.

***Should I have the Structural Engineer review the construction?***

By all means! This is your best assurance that the construction was completed in accordance with the construction documents (drawings, notes and specifications). The Engineer serves as a second set of eyes to catch any changes or items that are not completed adequately or “fall through the cracks.” It is also an opportunity to confirm whether suitable products and proper installation procedures were used. A contractor may also be more conscientious knowing that his/her work will be reviewed by a design professional.

Ask the Engineer to review the work and prepare an “affidavit” letter (letter of completion) for you and the Building Department, stating that the work was completed in accordance with the construction documents and sound engineering principles to the best of his/her knowledge. The local Building Inspector will often perform a “walk-through” inspection. They are looking at the structure in general and do not verify that all of the structure conforms to the structural documents. The cost of engineering is only a fraction of the cost of construction and it ensures that you have a “complete” project as it relates to structure.

## QUESTIONS AND ANSWERS (continued)

***We purchased some floor plans from a book to build our new home. Do I still need an engineer?***

It is strongly advisable that you have a structural engineer review the drawings for structural adequacy and suitability relative to the site that you will be placing it on. It may seem like a bitter pill to swallow, since the structural engineering services will require additional fees beyond the cost of the architectural drawings. However, drawings purchased from a book or online seldom include adequate structural information for your local building codes. The provider of the drawings usually and rightly recommends that you engage the services of a structural engineer to complete the design.

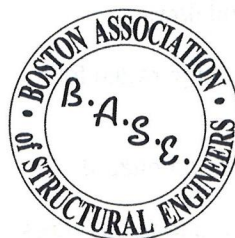
By law, because an engineer is obligated to produce engineering designs under his/her own review; they cannot take a set of drawings and just stamp them. A new set of structural drawings would need to be produced or a separate, stamped letter of review that attests to the structural adequacy of what has been designed. When a complete structural design is given to a contractor, you will receive a more accurate price to complete the work.

***How is a structural engineer paid?***

Engineers are generally paid on an hourly or lump sum basis. Typically they will ask for a retainer at the project outset and payments at specific intervals and/or upon completion. Some engineers will require final payment prior to issuing an “affidavit” letter. Because methods could vary between engineers, it is best to ask them about their fee structure. Typically one can expect to pay an engineer for all consultations (including the initial visit) and the subsequent analysis and/or design and any peripheral costs for travel time, printing design-related documents, etc.

If you are unsure about the need for a Structural Engineer you can contact your local building inspector or a Structural Engineer.

For additional information contact:



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