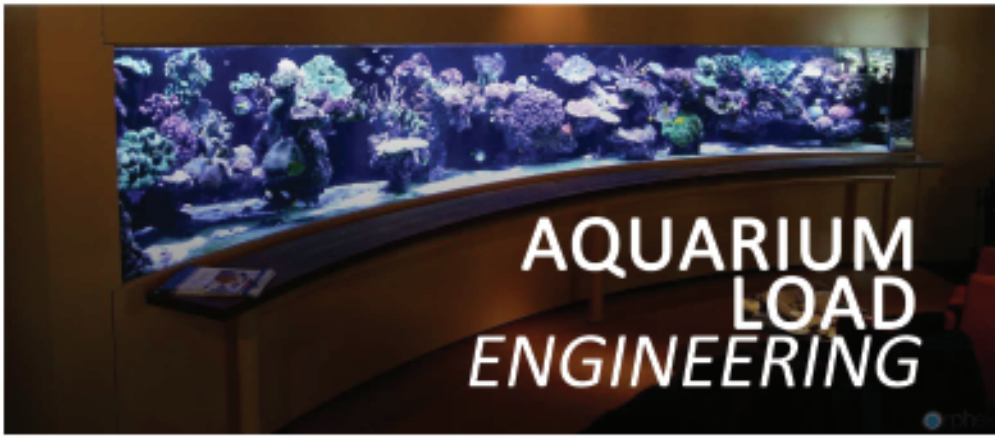


AQUARIUM LOAD ENGINEERING

In my five years studying Structural Engineering at Sydney Uni I have picked up various habits that often cross over in to my day by day life. The upshot of this is that I will tend to view everyday occurrences, such as my fishkeeping hobby, with a view to the engineering principles that can be applied. One thing that keeps popping up with people not exposed to engineering or construction in any way is the effect of aquarium loads on residential wooden floors or furniture. While I am by no means a specialist in this area (*Treat this as a disclaimer, as I am unemployed as far as engineering jobs go, and I have never had a major course on timber structures!*) I feel that I have the ability to research and analyse this area with some confidence. Perhaps I can dispel some misconstructions along the way.

Being able to research and identify reliable resources on the intenet, i.e. those which make sense from a technical perspective rather than hear-say or outright misinformation, puts me in a position where I may be able to help people potentially avoid a disaster. A common question from hobbyists is whether their floorboards will hold the weight of their at-capacity aquarium and how they can mitigate the symptoms of overloading. By applying a few relatively simple concepts to some research on your part you can completely avoid loss due to inadequate tank support. I would apply these principles wherever I am dealing with a tank above 200L capacity.

First, there's no simple yes or no answer to a residential flooring problem and this is in part due to each home being different. You should familiarise yourself with your own house layout by checking yourself if possible, or even better getting your house files which can be obtained from the ***ACT Planning and Land Authority*** for a small fee around $20.

For the sake of this article I will provide a basic image of what a typical frame would look like for a residential building in Australia sourced from a government website. Note that we will be defining all buildings as Class 2 or 3 (residential) according to the Building Code of Australia (BCA).

The definitions you will need to understand are:

Beam – The timber or steel beam that supports the joists and connects to the columns.

Column – The columns are vertical and transfer the load from the beams in to the foundations.

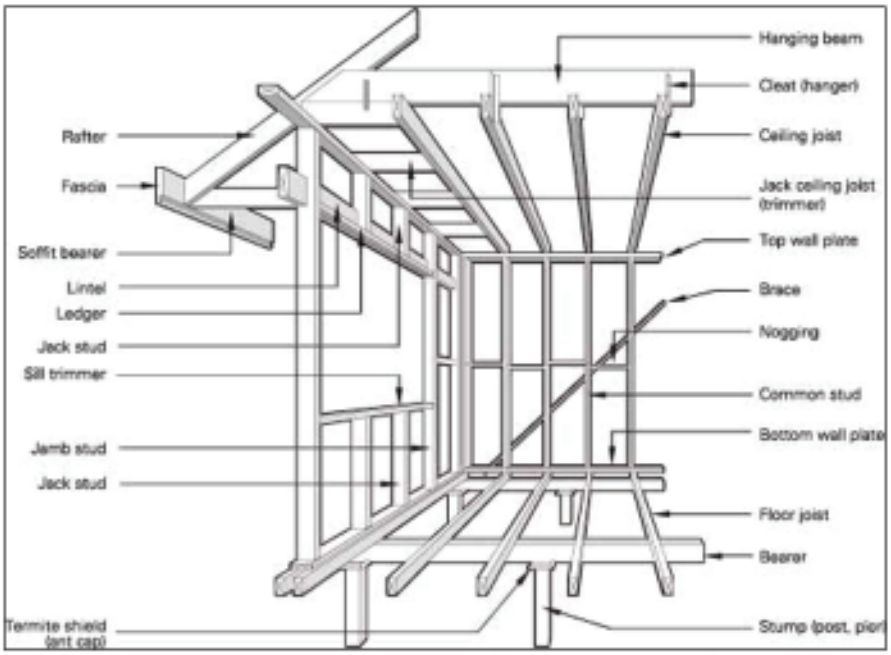
Joist – Smaller, beam-shaped timber members that sit atop the beams and transfer load to these and the bearing walls. The floor in the form of plywood is connected to the top of this. They are generally spaced 450 mm apart.

Bearing Wall – A thick load-bearing wall generally made of reinforced concrete or masonry that carries the weight of the house or apartment to the foundations.

Partition – Essentially a non-structural wall that does not bear loads, and serves only to separate rooms in the house.

Dead Load – This is the load due to the self-weight of any permanent parts of the structure, such as the beams, floors, services, etc.

Live Load – Also known as the "imposed load", this is the load applied by the weight of anything resting on the floor such as furniture, people and your aquarium.



http://www.yourhome.gov.au/technical/fs59.html

Typical wooden residential frame detail designed to *Australian Standard 1684:2006 – Residential Timber Framed*

A load of approximately **1.8 kN/m^2**, or roughly two adult males standing in a one metre by one metre area, is a typical design value for a floor. This method used by the BCA and Australian Standards assumes a uniform load over the entire floor, which is obviously rarely the case.

You will notice that this doesn't seem like much, and that your larger aquariums at 4' or above are going to be three or even more times the weight of two adults on a square metre of flooring.

What you may not know, though, is that these loads are determined as **very conservative** estimates for a safe load long-term to compensate for the unknowns, such as supports having holes cut in them for DIY jobs. This value is a **minimum** and there will be areas much stronger than this over the floorboards.

The key to finding the best place for your large aquarium is finding where in the house these zones of much higher capacity lie. In general they can be found in the following areas:

- Above columns
- Above bearing walls
- Along beams
- Where joist spacing is shorter
- Where joists and beams span a shorter distance

If you have access to a basement to see the physical spacing of your floor joists then do so, otherwise you must rely on drawings.

Of the above areas that we determined to be strong zones, some are less likely than others. Joist spacing will generally be uniform throughout the house, so you won't find anywhere to comply here. of the floor as near as possible to the bearing wall.

Where the joists span a shorter distance, the rooms are generally smaller, which is the opposite to where you want your nice big display tank to be.

Now we are left with placing the tank near a wall, column or beam. Columns usually continue on to something else above it, but you may be in luck in finding an area of the floor as near as possible to the bearing wall.

Improving your floor bearing capacity:

- Place your aquarium near a **bearing wall** and not a partition wall.
- Place your aquarium so that the joists are **perpendicular** and that as many joists intersect the aquarium footprint as possible.
- **Brace** your joists or add more joists to decrease the spacing and increase load capacity.
- Have a **continuous footing** for the aquarium rather than four individual legs.

View of floor joists, beams and subfloor from below.

For further reading, these resources may be useful:

http://www.yourhome.gov.au/
http://www.woodsolutions.com.au/
http://www.wespine.com.au/class2&3.pdf
(great for diagrams)

Assumptions to avoid:

- Do not assume that plywood will distribute the load significantly, as it does not.
- Do not assume that reinforcing joists with a method that puts holes in the joists will increase their capacity, as it may not.
- Treat each individual case separately and don't base your assumptions off another person's experiences.
- Do not assume that no deflection means the floor is okay, as there are other methods of failure that are more sudden and show no bending.

Brendan "deL" Ferguson
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