Going Up: The performance and cost advantages of concrete for residential second storey floors

The low cost and proven performance, in strength and service, that have made prestressed concrete floors a preferred construction method for commercial building also apply to housing. Many homeowners are now becoming aware of the advantages offered by upper level concrete floors.

A Concrete Advantage

The fire and acoustic performance of prestressed concrete flooring is, of course, well known. No other building material performs better, for the same price. While a one-hour fire rating is not a requirement for the average home, with concrete this added security is a bonus at no extra cost. A concrete first floor provides a minimum of half an hour fire resistance but for many houses this can be one hour and easily extended.

Similarly, the sound-insulating properties of concrete, while not mandatory in single title residential construction, can improve comfort levels and reduce stress by preventing noise overflow from high traffic areas into quiet zones. Concrete floors provide a barrier to airborne noise, and to squeaks and creaks, with no additional treatment. The airborne sound insulation (STC rating) of a concrete first floor is in the range of 47-52 dB, compared to a normal modern timber floor which rates at 30-38 dB. (See Figure 1 on page 22) When carpet is used on a concrete floor, the advantage in sound insulation over a timber floor is even greater.

Concrete upper floors are best supported on concrete masonry or precast concrete panel walls. When it is appropriately insulated, this concrete mass of walls and floors provides an enormous heat sink and stores energy for later use.

While this thermal mass/ heat storage concept is well understood in terms of reducing winter heating costs, its reverse summer effect is not so well known: the thermal capacity of a concrete first floor reduces peak temperatures during summer by around five degrees Celsius, providing a more comfortable environment during hot weather.

In winter, temperature stability is achieved by the structural mass absorbing heat generated by the heating system and by incidental gains through windows or created by the occupants, lighting or other equipment. This stored heat is then radiated back into the home during cooler periods – at night or when the heating is off.

An example, taken from a BRE (British Research Establishment) report shows minimum internal temperatures for different houses heated morning and evening (see Figure 2). Houses of heavier traditional construction are shown to maintain a minimum temperature of between 12-15°C, while the temperature in houses of more lightweight construction is shown to fall towards 7°C – below the temperature of 10°C recommended by BS 5250 to reduce the risk of condensation (and subsequent mould growth).

Well designed concrete homes are healthy homes: in addition to the reduction in condensation and the impact of effective noise control on family stress, concrete floors release no toxic gases and provide an environment that does not favour dust mites. Concrete and steel are currently also among the easiest building materials to recycle; environmentally concerned owners can be assured their floor is recyclable at the end of its useful life.

Design Impact

From an architectural perspective, prestressed concrete floors provide an ideal substrate for tile, stone, or parquet finishes, and the floors are very stable – without the movement and vibration of other materials. No special treatment is required for wet areas or under fireplaces. Recesses for mat wells, shower floors or weather proofing are easily accommodated, and the surface of the concrete can be coloured and polished for effect.

Concrete floors are typically half the thickness of timber floors, which allows building height to be reduced, saving cost on the walls or allowing more floor area within projected shade or sight lines. Prestressed concrete flooring sections also make ideal roof members, giving additional thermal mass for heat storage and dramatic thin cantilevers.

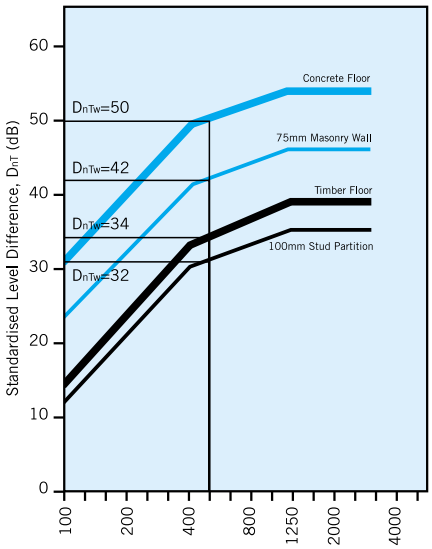

Figure 1: Comparative sound tests

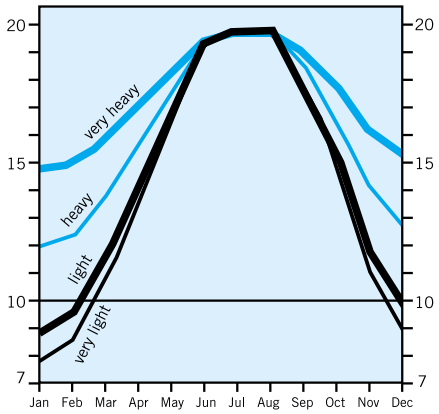

Figure 2: Comparative minimum temperatures in houses of different construction

Structural Requirements

Structurally, concrete floors could not be simpler: the prestressed concrete flooring supplier designs the floor for the loads and spans required. Prestressed concrete is at its best carrying heavy loads over long spans. Loads from stairs, third storeys, roof support columns, and even spa baths are easily accommodated without the need for mid-span supporting walls or columns below. Cantilevered balconies can also be very rigid.

A common misconception is that the extra weight of a concrete floor will require larger and more costly foundations, or more complex earthquake design. In reality, the reverse can be true; the wall support provided by a rigid concrete diaphragm can lead to a reduction in wall reinforcement and smaller foundation dimensions, particularly if the foundation is a draft foundation.

On Site

While concrete upper-floor construction may require skills that many house builders are unfamiliar with, it is no more complicated than a ground floor slab. Be aware that access for delivery trucks and cranes is necessary for suspended concrete floors, and that temporary props and bracing may be required for some precast systems. Also services such as plumbing lines, drains and electrical conduits do require pre-planning, but these can in some instances be laid in the topping concrete.

Demand for upper-floor concrete construction looks set to grow, as the market becomes aware of the cost and performance advantages it offers. Second storeys won't be all that's going up.C

Prestressed Concrete Flooring Systems

Type of Floor	*Span Range*	*Advantages*	*Cost $/m² for the floor in place*
75 mm flatslab	Up to 7.5 metres	A thin floor fast to install and with a flush soffit. Thick topping allows services to be cast into the floor.	$110
Prestressed beams – timber infill	Up to 8 metres	Light weight precast units can be placed with smaller cranes. Requires a suspended ceiling which allows for later installation of services.	$105
Hollowcore	Up to 12 metres or more	Does not require props. Flush soffit. Services can be fitted into the cores. Cores also provide a simple heat recovery system for solar energy.	$115
Double Tees	Up to 12 metres or more	Does not require props. Requires a suspended ceiling which allows for later installation of services.	$120