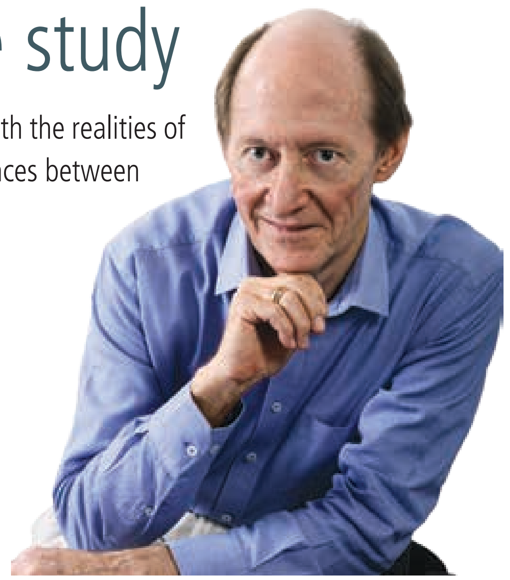
House Crawford: an LSF case study

MechChem Africa columnist Gary i Crawford of Crawford Consulting gets to grips with the realities of his light steel frame (LSF) house project in Hartbeespoort and highlights key differences between LSF and building using traditional materials.



Four years from design of House Crawford by Sharon Lane Crawford; the Light Steel Frame (LSF) design and detailing by Nardi van Zijl; and the foundation and structural engineering design by Mike Stoop of Andy Kolver Civil & Structural Engineers, the plans for this novel home are now approved and construction has begun.

While expecting lengthy delays in having the plans approved by the Gateway Manor Home Owners Association, the Madibeng Local Municipality and the National Home Builders Registration Council (NHBRC) – we took the opportunity to build the boundary wall. At the required height of 1.8 m, the plus 100 m wall incorporates a 12.0 m section of unclimbable and highly tamper resistant 'ClearVu Invisible Wall' panels to take advantage of the view of indigenous trees and mountains.

Amazingly, the building plans were approved in a matter of days, courtesy the Estate Architect, Gavin Wreford, and the efficient staff of the Madibeng Building Control Division. Cooperation and friendliness seem to be the norm in Hartbeespoort.

A "Hi Gary," greets me as I enter Basil's supermarket or the local hardware store; on visiting Vovo Telo restaurant for the third time, we're offered our 'usual' table by owner John; and the ladies at non-card-accepting 'home-cooked' gourmet meals shop, Mr Salad, extend me 'docket on a spike' credit when I pitch up cashless. We even get to jump the queue at funky eatery, French Toast, where our Afghan hounds have become the Sunday centre of attraction.

We moved to Hartbeespoort (I've yet to call it 'Harties') to be closer to the building site of our 'off-the-grid' LSF residence. We received, as a bonus, instant acceptance and friendliness.

LSF: the underpinning rationale

The starting point for this project was to design a home that would incorporate the latest in environmental practices. In researching the appropriate materials, carbon footprint, longevity, economics, ease of construction and appearance, the Light Steel Frame (LSF) system emerged as the clear favourite.

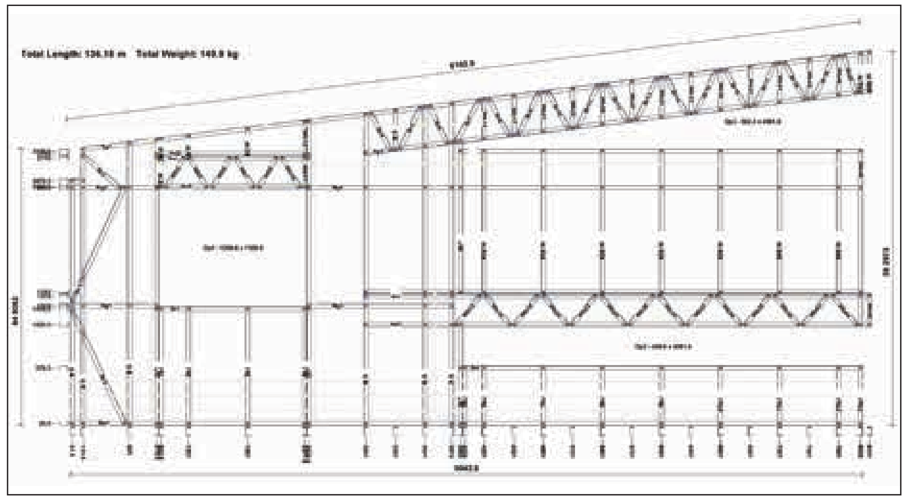
The home had to accommodate the needs of two mature (yet active) adults, two Afghan hounds and a regular flow of visitors. The building had to be low maintenance and incorporate features conducive to environmental stability. The two identical bedrooms had to have direct access to the open plan living space.

An internal 'eco garden' will control airflow, while leading off the garden will be two studios flanking an entrance hall.

A characteristic of the building design is the use of polycarbonate sheeting supplied by PALRAM. The cladding of some walls will see the conventional drywall cladding replaced by SUNLITE multi wall PLC sheet in an opal colour – this to provide a theatrical 'glow-at-night' feel.

The same material is specified on interior doors, all of which will be 'sliders' rather than conventional hinged doors. The doors will be suspended on 'barn door' sliding mechanisms of our own design. Because of the artistic quality of the mechanisms, they'll be left exposed.

At the time of writing this column, the foundation layout is to commence. A detailed examination of soil conditions has been completed and various types of foundation from 'raft' to steel piles were considered. In end, we decided to use a 'strip' foundation and slab.With a slab/screed of 100 mm thick, the floor will extend to the exterior wall brickwork. Since this is the surface on which the house structure will stand and it will be power floated.



The North wall frame design, for example, shows the framing around the bathroom window and the 'low level' bedroom window.

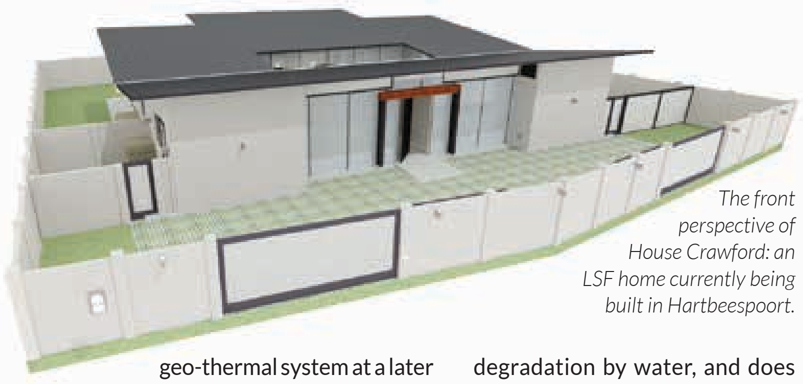
The case for under-floor insulation

Besides the usual moisture barrier and mild steel reinforcing mesh, hindsight advocated the use of 40 mm high-density (20 kg/m^3) expanded polystyrene (EPS) as under-floor insulation. It has been proved that an insulated floor without any under-floor heating can be expected to be warmer than an uninsulated floor by four to five °C. Previous use of EPS as under-floor insulation in our 600 m^2 Hurlingham residence proved that it wasn't necessary to turn on the under-floor heating in order to achieve a comfortable living environment.

As a rule of thumb, if using electric under-floor heating, insulation should be installed between slab and screed to minimise the volume of concrete to be heated. If solar heating is to be used, insulation should be installed below the floor slab, as the slab will gradually release retained heat into the building at night.

SANS 10400XA requires that all heated floors be insulated to a minimum thermal resistance (R-value) of R-1.000, which translates into an EPS thickness of 30 mm for the 200 m^2 floor area.

Although it is still to be decided whether under-floor heating will be necessary, a grid of corrugated stainless steel tube will be laid in the concrete slab. Then, if necessary, the tubes will be connected to a solar heating or geo-thermal system at a later stage. The corrugated stainless steel tubing will be supplied by leading product developer, INOX Systems.



The front perspective of House Crawford: an LSF home currently being built in Hartbeespoort.

Some statistics:	
Excavation of foundation trenches	100 m^3
Compaction material	55 m^3
Foundation concrete – 20 MPa	22 m^3
Bricks to foundation plinth	10 000
Backfill	170 m^3
Underlay – 59 micron PVC	270 m^3
Under-slab insulation – 40 mm 20DV EPS	73 sheets
Floor concrete – 25 MPa	22.5 m^3
Foundation reinforcing	901 kg
Surface bed reinforcing – Ref. 245 mesh	17 sheets
In-slab heating tube – INOX corrugated SS	TBD

CEO Eric Levi proudly advises that INOX tubing is purposefully designed for hot and cold water applications. The product conforms to SANS 1689 and has been tested rigorously to ensure extended service life at pressures up to 1 000 kPa.

To minimise heat transfer through the floor from adjacent soil, EPS sheets will be installed against the foundations to the depth of the foundation or 600 mm, whichever the greater.

Why expanded polystyrene? It is recyclable, extremely safe (no CFCs or HFCs), has the best price/performance ratio of any insulation, almost as light as air (saving transport fuel costs), is easy to handle and install, presents no dangers to health, resists degradation by water, and does not decompose.

Key aspects of LSF construction

In all LSF projects the level of the foundation/slab is of paramount importance to ensure a level and plumb structure. The slab dimensional tolerances are equally important as the LSF outer wall sections are positioned at the edge of the slab. In the case of House Crawford, a 100 mm slab/screed combination will have to match the steel structure precisely to allow the first layer of cladding (0.5 mm of galvanised mild steel) to extend beyond the steel structure's bottom rail for waterproofing purposes.

During the slab curing phase, the 2 229 m of 89 mm frame master sections in 0.8 mm BCM G550 material galvanised to a minimum of Z200/AZ150 grade will be collected from the roll-former and assembled on site into manageable 'frames.'

The North wall design, for example, shows the framing around the bathroom window and 'low level' bedroom window, giving a view of the garden. Also shown on this layout is the wedge-shaped clerestory window in the bedroom. The framing drawings will be used by Contractor Xolani Ncube's construction team to assemble the frames.

The weight of the building's skeleton, excluding the roof, is 2 900 kg and it uses 2 229 m of galvanised steel coil. The skeleton will require 10 000 Tek screws for its assembly and 150 chemical anchors to secure it to the slab.

In the next column we'll deal with the interesting topic of cladding and waterproofing the structure. ❑