GETTING THE RIGHT PROFILE

Not only is technology changing building design, it's changing product development. Build talks to Dave Stampa, National Manager for Steel & Tube Roofing, about the process involved in the development of their latest roofing profile.

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Designing a metal roofing profile means creating the right combination of strength, durability, aesthetic appeal and ease of installation. But finding that combination is not simple.

'The main driver for our new commercial profile, code-named ST963, was to produce a more efficient section as an alternative to traditional high-rib profiles,' says Dave. 'Most commercial profiles come out of a standard coil feed, so it's all about getting the best profile with maximum spanning ability and the best strength and performance characteristics that you can for a given amount of material.'

It's also important to give specifiers, architects and engineers a product that is easy to lay and has a multitude of practical applications.

Computer models and simulation narrows choice

The design process began by narrowing down several concepts to a choice of profile candidates.

'We had what we thought were seven potentially good ideas for profile configurations. We created computer models of each one and tested them using a simulation to see how the computer predicted they would perform,' says Dave.

The simulation applies loads to the roofing membrane that correspond with real-world building situations. It applies loads under a variety of structural design conditions, adds the effects of wind uplift, cyclic loading and considers all the design variables that are likely to be important when specifiers go through their selection process.

Other factors important to the performance of roofing, such as corrosion resistance and durability, are determined by the composition of the raw material, rather than the design of the profile. In this case, New Zealand Steel's Colorsteel product, which has well understood composition and physical properties, was considered the basic raw material.

The test rig in use. Prototypes of new products undergo a battery of tests designed to replicate real-world scenarios.

'The simulation testing is really a computer replication of the stresses that the product will encounter during its manufacture, installation and use,' Dave says, 'but the limitation is that even the best computer simulation cannot accurately replicate the exact performance of the final finished product. It will give us a good approximation, but not the fine details.'

Next stage: hand-folded metal prototypes

However, physically testing metal samples can yield a lot more information about real-world performance.

'After computer modelling and simulation, we'd narrowed it down to a shortlist of four profiles,' says Dave. 'The next step was to try to produce prototypes of each of those profiles in order to carry out more comprehensive testing.'

Small prototype runs can normally be made by folding material by hand, but the technique is somewhat limited when dealing with complex profile shapes, especially when compared to what can be produced using an automated roll-forming machine.

'We went through a number of iterations of hand-folded prototypes to try to replicate the design as closely as we could,' he says.

The prototypes were subjected to a battery of physical tests that were again designed to replicate real-world building scenarios. The tests considered factors such as dead loads, wind loads and ease of installation in order to expose weaknesses that the computer simulations might have been unable to detect.

'We got close enough using that process that we could eliminate some of the proposed profiles because they clearly were not performing adequately or were performing differently than we expected.'

That eliminated the two worst performers, leaving two candidates for the final development.

Nearing a decision: roll-formed prototypes

'By now, we knew that in order to come up with tests that would better replicate the final product, we needed to build a roll-forming machine that could produce it as though it was being manufactured in its final form.

So we ended up making two roll-formers that could accurately produce each profile in cross section,' says Dave.

'That was a huge investment but it meant that we could carry out the last physical performance tests prior to building the machine that would manufacture the high-volume product.'

He says that test samples taken from a roll-forming machine give a good idea of what to expect from the final product – the product's aesthetics become apparent, and test results provide the best indication of how a profile will perform under actual conditions.

However, final testing can only be carried out on actual product.

Last step: volume manufacturing

'Once we'd selected the best profile design, the final product proceeded to volume manufacturing which, in this case, was a full-width sheet,' says Dave.

'We then took samples of the final product and put them into a test rig set up and calibrated by the New Zealand Metal Roofing Manufacturers Association. We used that test rig to test the profile to destruction under concentrated point loads and uniformly distributed wind uplift loading.'

The final series of tests confirmed the product was suitable to market.

Technology adds speed and confidence

As product development cycles speed up, high-tech virtual prototyping has enabled designers to quickly define a set of desirable performance criteria for a new product. Unsuitable designs can be eliminated without the time-consuming process of manually shaping and testing each possibility.

Unlike traditional design methods where loads were calculated as simple static forces, computer simulation and finite element analysis allows for a much more comprehensive range of load and stress tests.

By combining traditional hand prototyping with real-world testing and physical evaluation to back up computer-generated results, manufacturers can now gain much greater confidence when committing expensive tooling and manufacturing equipment in the ramp-up to production volumes.

Although many building owners take their roofing product for granted, it's likely to have undergone considerable research and testing effort that ensures it can withstand the harshest New Zealand conditions.