Smart Building
The Hague, The Netherlands

Ed Van HINTE

1 Game computer lid

Like you can read in my bio I don't have a background in building or architecture. I am very good at not being specialized in anything. Recently I designed a game computer without a screen, and this is the lid of the box it comes in. Material: plastic granulate baked in an oven on a tray, like gouache.

Material was meant for floor tiles graduation project Academy.

Became a total disaster. Baking in batches didn't work and one by one took to long. Did look good and would be sturdy material that because of its roughness would keep on doing so. Long lasting >> the lid. Also shows that the borderline between material and structure is fuzzy. Material is becoming something that you design together with the structure and the process, rather than something you choose.

2 Computer

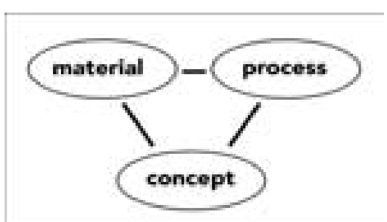
Brief explanation

3 Trinity

It demonstrates that a material and concept have to match the process by which it is made. And also that a different concept can work with the same material and process. This is a very important picture in all kinds of design.

In building it is a starting point too, and it is becoming more so because lightness is gaining importance. Humans used to have to carry everything, animals helped, machines helped better, but now energy consumption is getting more and more limited. Expensive, so lightness is important for affordable transportation.

Show some architectural viewpoints, just to get into the building groove.



4 Van Nelle

Buildings: architectural affinities. The starting point of modern functionalist building: steel glass, geometry

5 Hong Kong bank

Norman Foster direct hereditary: Appropriate technology, although we can observe that Foster likes to show structures that look appropriate (modern, industrial, ingenious) and that technology has to comply with those looks, even Norman Foster.

6 CCTV Beijing

Now this building, now being built in Beijing, designed by Rem Koolhaas, spectacular structure 230 meters, massive amount of complex floor space. Ove Arup's office spent a year doing the calculations, steel beams along the tension lines. It is the Dutch affinity with concepts. Building as a logo, plus accommodating open organizations because of less elevator separations.

7 WoZoCo

By MVRDV. Building for elderly people. Same lust for simple concepts, resulting in not very efficient structures, but they also show anything is possible.

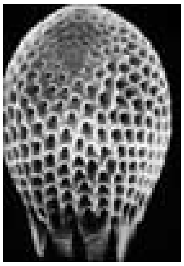
8 Frank Gehry

An architect in his very own right. He sculpts buildings and all structure is subordinate to that. Another spectacular creation for a computer intelligence lab at MIT.

9 Lars Spuybroek

Here we have an architect who I fascinated by what you can do with computers.

They can visualize any shape and even create interactive virtual buildings. Alas, when you actually want to build something like this, you are still left with artisans, welders for instance.



10 Radiolaria

Nature is an inspiration to some architects, and it is true that plants and animals have a much more refined structure than what architects can do. This is the outside skeleton of a specimen of a kind of animals called Radiolaria, a few millimeters. They make their own outside skeleton.

10 Calatrava Lisbon

Santiago Calatrava probably is the most capable architect right now in deriving the structures of buildings from bone and plants. I hope to see his stadium in Athens on Sunday. Now these images all show buildings by a certain architectural elite. They all put the mark on the concept. Only in the case of the likes of Calatrava are we getting something that has to do with structural efficiency. Of course the bulk of what is built all over the world has very little to do with all this. It is simply a pragmatic business that is quite successful despite its ongoing inefficiency.

11 Vinex

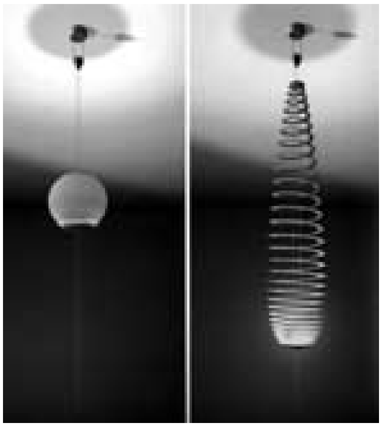
In the Netherlands housing development is relatively efficient and mostly controlled by government. Strange things occur because of that. A friend of mine bought ground that was destined for free architecture. Together with friends: let's do the same. That is more efficient. They were not allowed to build the same houses on a row (4 million) because free architecture is not meant for that.

12 Tirana

Pragmatic modernist architecture in Tirana.

13 Rubble

Basically building is a relatively primitive and inefficient process. It involves a lot of labour and cheap materials. This could change in the future, judging by the general direction of technological development.

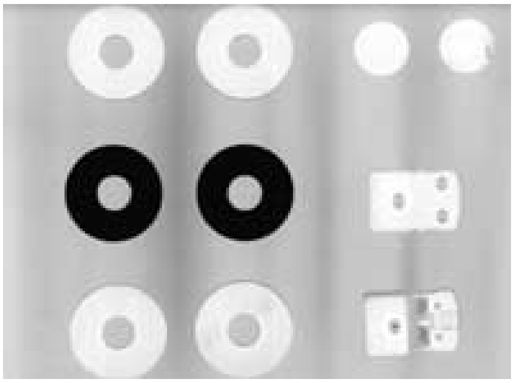


14 Ron Arad SLS

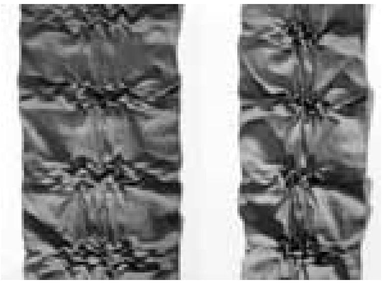
The other extreme is a process entirely controlled by a computer. Selective Laser Sintering. The software contains a model that controls a laser device that melts together plastic granules, layer by layer to build a product. Architectural models have been made in similar ways. This technology will not acquire a large enough scale for buildings, but the computer and robots are already used in building high-rises and tunnels and for cleaning.

15 Piezo

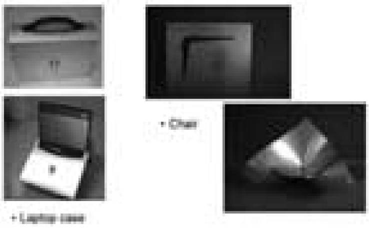
Some things will become more automated. Piezo electric ceramics and other materials are used as sensors in feed back systems.



16 Nitinol



Feed back systems need actuators too. They can be made with motors or materials that can exert forces. Nitinol or memory metal. Now this is where you are going to have to be careful: the effect may be tempting, but does it really do something meaningful. Sleeve nonsense. Explain.



17 Hylite

Materials have to make sense. Some 10 years ago a Steel giant in the Netherlands came up with Hylite, a laminate of aluminium and polyprop. It would be light and easy to process in for instance the car industry. Aluminium in thin layers however is quite vulnerable. A few heavy hailstones and the hood of your car is dented. They still try to find applications, concepts.

18 Straw

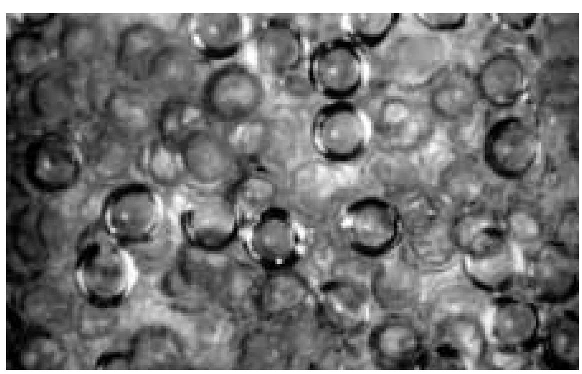
Ah, one of these effects. Temperature sensitive plastic. The cold drink colours the straw. Won't make any difference if the drink has the same colour. Fun!

19 Composite glass

Now this is an interesting combination of glass and a metal honeycomb structure. Relatively light, compared to glass. Lets light through in a special way. Deals with the obsessions of many architects for translucency and transparency. Important part of their conventions.

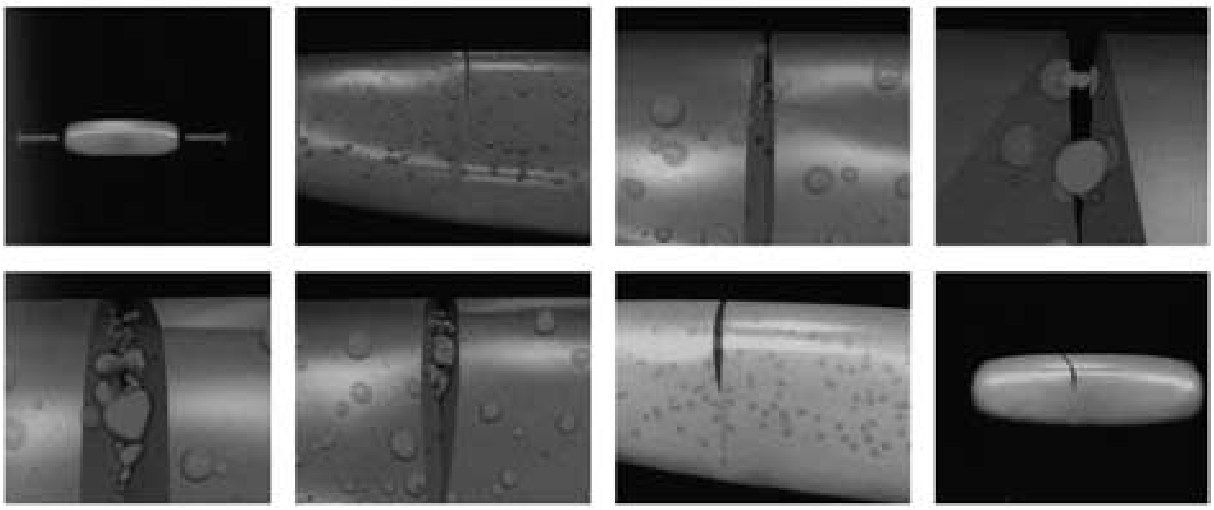
20 Translucent concrete

A Dutch architect once wrote about 'sappy', the ideal material that would instantly solve all architectural problems. This comes close. It is translucent concrete and they're currently experimenting with it. As far as I'm concerned: effect. Why would everything have to be translucent? There's nothing wrong with a bit of darkness here and there.



21 Self repair

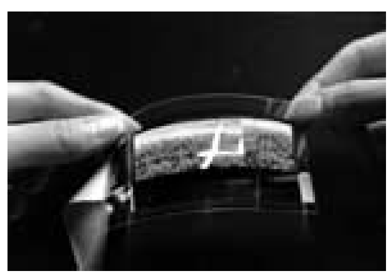
Feed-back systems include materials or structures that can repair themselves when something goes wrong. This is an illustration of self repairing polymer. If there is a crack little bulbs of resin undergo a chemical reaction that forms fresh material to fill up the gaps. There are experiments like this going on in concrete too.



22 Leak stopping

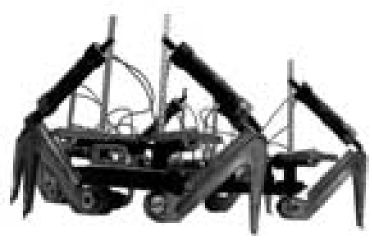
Last week I found an interesting new idea to stop underground leakage. This is a picture of the test site. They prepared containers with holes in them. What they do is feed carbohydrates and sugar into the ground. It will concentrate near holes and there bacteria will consume it. They love candy. Consequently they excrete a slimy substance that closes the hole. The article didn't say anything about the smell.

23 E-ink



You probably know that flexible screens are almost ready for the market. No doubt this will be the beginning of developments that cannot entirely predicted. Clothing with screens. Entire curved walls with screens. Some architects like Lars Spuybroek expect something like virtual architecture or buildings that automatically adapt visually to the weather or, sound or whatever. Scientists are also thinking of interactive room atmospheres. You can choose imagery according to your emotion. Personally I would hate that.

24 Polymer muscles

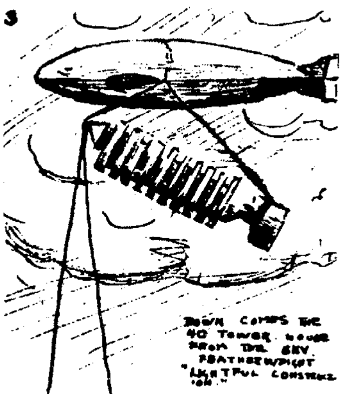


Artificial insect from the structural point of view. Explain. Another option to make buildings more intelligent. Feed-back and interaction.

25 Zeppelin Hangar

This is not about the airship but the material behind it. Airships are quite inefficient vehicles, but they could be interesting cargo lifters: low speeds, short distances.

Flexible composite. Cloth made of glass fibre plus Teflon. Composites are combinations of two or more different materials. This is where material really becomes a structure or a construction themselves. Reinforced concrete is a composite, but usually the name is given to a combination of fibres (glass, Kevlar, polyethylene, carbon) and a resin, both thermosetting and thermoplastic. Several functions are combined, and who knows maybe there will be composites that are also screens and heat insulators. This one is strong, light, flexible and translucent. They have the potential to become new building materials, because they can be very light.

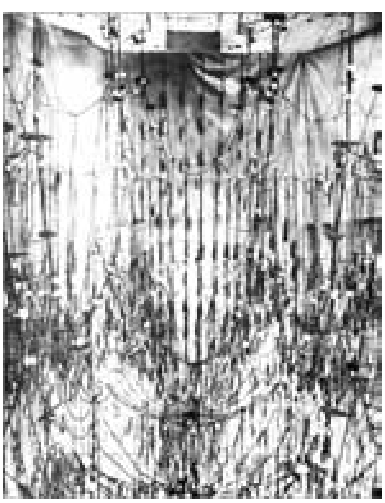


26 Zeppelin Buckminster

Lightness is gaining importance. Buckminster Fuller foresaw that and it is an angle I like to choose. The rationale behind that is quite simple: in primeval times man had to carry everything himself. Everything had to be light because of it. They chose light materials and invented composites. Then they learned to employ animals. Later machines that became stronger and stronger to carry all the more heavier loads. Around WW II heaviness was at its peak. After that artifacts are becoming lighter again to accommodate efficient transport. Since energy is becoming more and more expensive this trend is likely to continue.

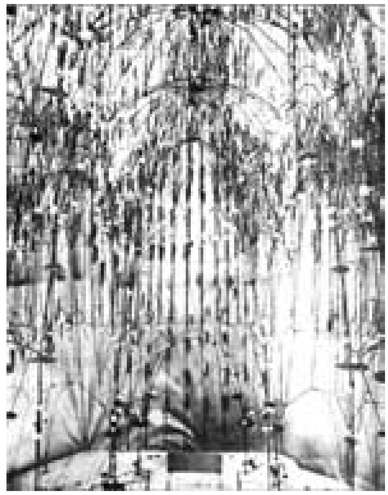
27 Tension

You know that lightness results from structures in which tension is the dominant stress when loaded. Some materials are better qualified for pressure, like stone, some are reasonably good in both, like metals. Fibres are the best in tension. Weight provides fibres with form. You could say that Antonio Gaudi marked the change from pressure to tension. Historically that would be wrong, but it is a nice symbol.



28 Gaudi down

Gaudi designed a building with pieces of string and weights to mark the loads. They can still be seen in Barcelona.

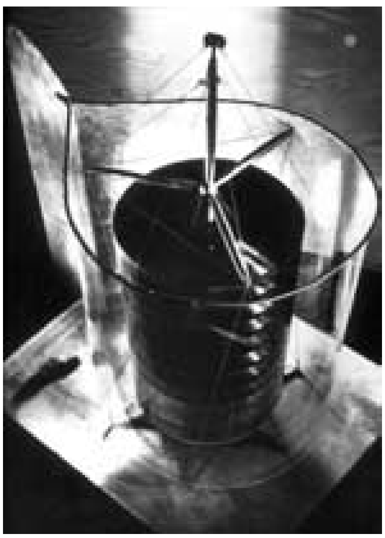


29 Gaudi up

Then he went to his masons and said: make this for me, but do it upside down. This simple principle worked, well, partly. You cannot just turn tension into pressure. For pressure you need thickness to prevent buckling. And as soon as you introduce thickness you get tension forces. Stone and cement cannot deal with that so there are cracks in some of Gaudi's structures.

30 Dymaxion house

Richard Buckminster Fuller was the master of lightness and tension. He designed this dymaxion house. Eight floors, complete with furniture. The whole building weighed 8 tons and could be placed on its sight with a zeppelin, theoretically.



31 Tensegrity

He invented the principle of tensegrity, by which you can build a stiff structure with cables loaded with pure tension, interlinked by pressure bars. This principle is omnipresent in nature. Even our own bodies can stand upright because of tensegrity.

32 Dartmoore bridge

The development to lightness can be illustrated with bridges. This is the most primitive kind, found in England. About 1200 years old. Pressure and bending. Bending forces are not very healthy for stone because of the tension in the bottom. I also found broke bridges.

33 Arch bridge

Here we have a beautiful example of a classic bridge in which all forces are exclusively of the pressure kind. There is a limit to the span. The English engineer Brunel became a master in this kind of bridges, and other kinds too.

34 Suspension bridge

Suspension bridges like this can be found all over the world. Recently they experimented with building such a bridge in Peru, with a special kind of grass that grows in the mountains. Local people built it in two days, from harvesting the grass to the finished bridge.

35 Foster bridge

The bridge near Tate modern in London by Norman Foster look ingenuous, but this is doubtful. The cables that support the deck are almost flat, which I suspect allows a bit too much torsion. They did have problems. Apparently when every body walked the same pace, and people do that, the bridge started moving.

36 Golden Gate

One of the most beautiful suspension bridges: San Francisco. Elegant. One disadvantage, they have to paint it over and over again to prevent the steel from rusting.

37 Golden Gate construction

This illustrates how they laid the cables, that by the way are not twined but parallel so that the steal threads can move along one another.

38 Messina strait bridge

There are limits to steel. It can weigh too much. The plan to build a bridge between Italy and Sicily with the longest suspension bridge ever, spanning 3,3 km between towers has financial trouble. It is estimated to cost 5 billion euros. Experience shows that with an average of 45% budget overrunning in large projects this will be nearer 7 billion. But more importantly, the span is over the limit of what steel can do.

39 Messina computer simu

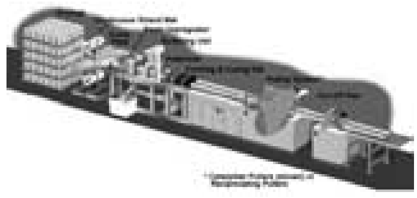
There is a good chance that this construction, if they ever try to build it, will collapse under its own weight. On the other hand carbon cables could work. Theoretically a carbon suspension bridge can span about 12 kilometers, simply because of a better ratio between strength and density. There is an important technical problem to be solved: anchoring a carbon cable.

40 Composite bridge

Composite bridges are being built. This one is in England. The deck is made from glass reinforced resin. An important advantage over steel is that the material doesn't need any maintenance.

41 Pultrusion

The process by which the deck is produced is called pultrusion. Fibres and yet to be set resin are laminated and pulled through a press and immediately cured afterwards.



42 Pultrusion

43 Air, etc,

air
polymer
fibres
intelligence

To make light building structures you basically need polymer fibres and intelligence, and air. Regardless of material or shape, the art of constructing lightweight structures thrives on intelligent distribution of mass, and thereby the points of gravity application, over space. Foam is a good idea. Generally air is a worthy material, provided it is enclosed. Other gases or fluids can do the job too.

44 Gas thieves

In this case the foil is used to contain gas in China. These people have stolen gas from an open well to use ate home, for cooking.

45 Casa basica

A spanish designer Martin Azua designed this very basic house from foil and air.

46 Airquarium

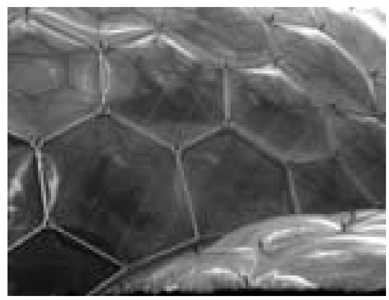
Another interesting air and polymer structure by Axel Thallemer of Festo Corporate design. He doe quite interesting experiments. Air and water.

47 Eden

Translucent buildings.

48 Eden detail

Not with ever popular glass but with Teflon foil cushions filled with air. Because of that the carrying structure can remain light.



49 Knotted chair

Fibres are quite interesting because they require working processes that are uncommon to those traditionally designing and building constructions. This chair by Marcel Wanders, now a design classic, illustrates that. It is knotted according to an old macramé technique. But the braid is made out of Kevlar, for the sleeve, and carbon fibres are inside. The whole structure is drenched in epoxy resin. The braiding and knotting thing is old, even the chair looks old, but it could not have been made before 15 years ago, because of the materials.

50 Wound stool

The same is true for this stool by Hella Jongerius. The high tech fibre is wound around a mandrel and consequently embedded in polyurethane with varying elasticity: the top is soft, the rest is stiff. Coiling or winding is a simple way to work fibre, but it may become useful even for very high buildings. I'll show this in a few minutes.

51 Exhibition hall

One of my favourites, also by Festo a German company in pneumatics. It is an inflated structure, in the sense that it has an pneumatic exoskeleton, like radiolaria. It is about 60 meters long.

52 Skeleton

Intelligence in a feed-back system is involved her. The skeleton is controlled by pneumatic muscles, the blue things. They contract when more air is pumped in. The muscles provide dynamic stability.

54 Chimneys

Now I will introduce to you a new process of building high structures, it is still in the laboratory stage at the laboratory for Lightweight structures, part of the faculty for aerospace engineering in Delft. The idea is based on a shape derived from this familiar form.

55 Sydney

It is applied in more pure tensegrity forms like this tower in Sydney

56 Kobe

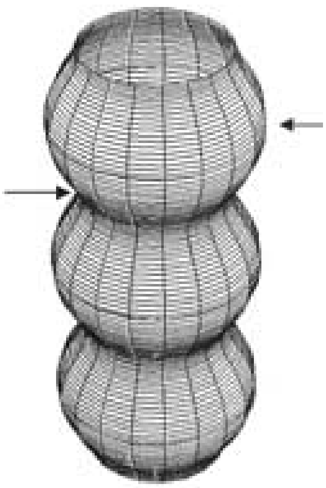
There is a central column with straight tension strands in a regular configuration to keep it upright.

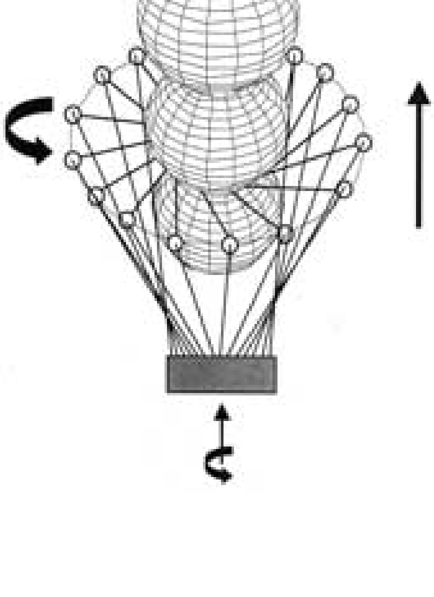
57 Hyperboloid

This hyperboloid is in fact mathematically the limit case of a shape like this

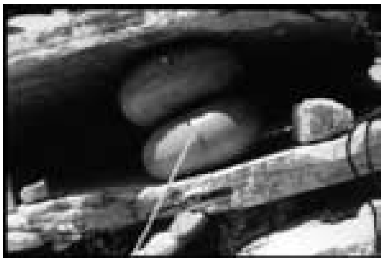
58 Isotensoid

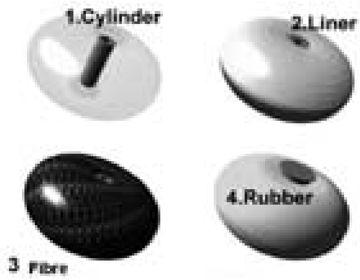
Isotensoid, it is characterized by the fact that it can be produced by winding fibres around a mandrel in a regular arrangement and when this shape is hollow and a fluid or pressurized gas is inside, the fibre will have the same tension everywhere, hence isotensoid.





59 Isotensoid winding





60 Lifting cushion

The principle is in use on a very small scale as a lifting cushion

61 LPG tank winding

And in a newly developed LPG tank.

62 LPG tank

The tank, consisting of plastic, fibres and latex, had trouble to be certified. The responsible team figured that it would be unsafe, since well, plastic. This hypothesis proved wrong. The ultimate test: throw a full tank in the fire and behold: no explosion. It just burned quietly, because the plastic melted. This shows that the properties of separate components do not determine the property of the hole structure.

63 Koussios

Anyway, a high structure could be made like this, extremely high as a matter of fact, because the outside wall would be under constant tension stress it wouldn't buckle. Several of these columns together could be the towers to support a building hundreds of meters high. And since pressure is easy to measure there could be a simple feedback system to trace and compensate for leakage.

64 Sequoia

The system would work like a tree: since water dries the skin it shrinks and therefore is put under tension stress that prevents it from breaking when there is a storm.

65 Airlift

A building like this could be built from the top down for a change. There could be a fleet of airlifts, like this floating saucer, one of which could contain a coiling, impregnating and curing robot. It would be the opposite of digging a hole. But this is pure speculation of course.