Lighter + stronger concrete = taller, greener buildings

by Gareth Moores

Lytag's Gareth Moores

As cutting costs remains the overwhelming pre-occupation for construction industries throughout the globe, maximising space by building tall offers an attractive solution. Gareth Moores, executive chairman of Lytag Ltd, explores how secondary aggregate can allow the innovative and sustainable design of tall buildings to go hand in hand with cost efficiency.

A 2009 study conducted by the Council on Tall Buildings and Urban Habitat (CTBUH) shows that more tall buildings were completed in 2008 than ever before. Despite underperforming economies and some of the highest profile tall projects being put on hold, the CTBUH expects 2009 to be near the '08 pace thanks to booms in Asia and the Middle East.

Lasting icons of expansion, power and supremacy, tall buildings remain a developer's dream, raising the profile of the area in which they are located and the value of the property and land that surround them.

THE TALL BUILDING DEBATE

The trend to build tall looks set to last far longer than the current economic

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25%
Of concrete aggregate must be recycled in developing London for the 2012 Olympic Games


Using LWA allowed F+P's Gherkin to achieve its tapered shape

downturn. Buildings are reaching new heights—when completed later this year, at over 800 metres the Burj Dubai will be the tallest building in the world and there remain a number of planned projects that promise to climb still higher.

But even as building tall becomes the norm across the globe, the concept is not without controversy. Debate over the impact of skyscrapers on our environment is especially pronounced in London, where high-profile figures including the Prince of Wales have lamented the changes that have been made to the London skyline.

Elsewhere in Europe, the French Green Party rallied against building tall in Paris and the UN's Education, Science & Culture Organisation (UNESCO) opposed plans for new skyscrapers in Prague. But despite negative media coverage, as urban population numbers increase the global tall building phenomenon shows no sign of waning.

Much is expected of tall building designs by today's clients and occupants, and even more will be demanded by those of tomorrow. Architects' plans must optimise floor space and buildings must offer the finest level of purpose-specific performance. Creating innovative and original designs that capture people's imagination is crucial for both commercial and residential buildings. While addressing the needs of the end-user has also become obligatory to stay ahead of the competition.

BUILDING SUSTAINABLY

The environment has become a priority for developers and the construction industry as end-users increasingly expect to live and work in green buildings—a trend that is only fuelled by the targets and legislation put in place by governments worldwide. A case in point: The Abu Dhabi Urban Planning Council, for example, launched the Estidama Buildings & Communities Programme in 2008 to promote sustainable development in the country, conceived to initially support 'Plan Abu Dhabi 2030'. Also in the UAE, the Dubai Municipality is in the process of ironing out the kinks in its new green building regulations for the desert city.

Industry response has been positive and is becoming increasingly global – the first international standard for sustainable construction was launched in 2008 by the ISO, allowing the industry to judge performance against an international benchmark. The creation of bodies such as the Emirates Green Building Council in 2006 to join the global Green Building Council network further demonstrates that sustainability has risen high up the industry's collective agenda.

However, as property and construction companies around the world struggle

against the global economic downturn, there has been debate over whether or not the sustainability agenda remains relevant. There can be no doubt that the need to lower the environmental impact of construction is greater than ever—an April 2009 report from the World Business Council for Sustainable Development (WBCSD) warned that countries throughout the world must put in place stronger building regulations if dangerous climate change is to be avoided.

The fact is, these environmental concerns are supported by good business sense. The astute response to times of economic difficulty is not to dismiss sustainability but instead to incorporate it into the construction process holistically, thereby maximising the business benefits that sustainability can offer.

Industries across the UK have already suffered heavily from the downturn that is facing the Middle East, with the construction industry being one of the hardest hit. So, what can be learnt from the UK?

Clients and contractors looking to make efficiencies now and in the future have recognised that sustainable practices can help their businesses through times of economic difficulty. This realisation has enabled UK companies to make considerable time and cost efficiencies and given them a crucial competitive advantage. As the downturn filters through to the UAE construction industry, clients and contractors of the Middle East would do well to remember this message.

GREENER CONCRETE

The energy efficiency—one of the key performance indicators of any construction project—of building and occupying a skyscraper is the subject of some debate. However, energy efficiency is not the only aspect of a building that plays a key role in enhancing a project's green credentials.

Material choice is one approach that can feasibly satisfy the requirements for innovative design, sustainability and cost efficiency. One easy way to meet these demands is building with concrete made with lightweight, secondary aggregate (LWA).

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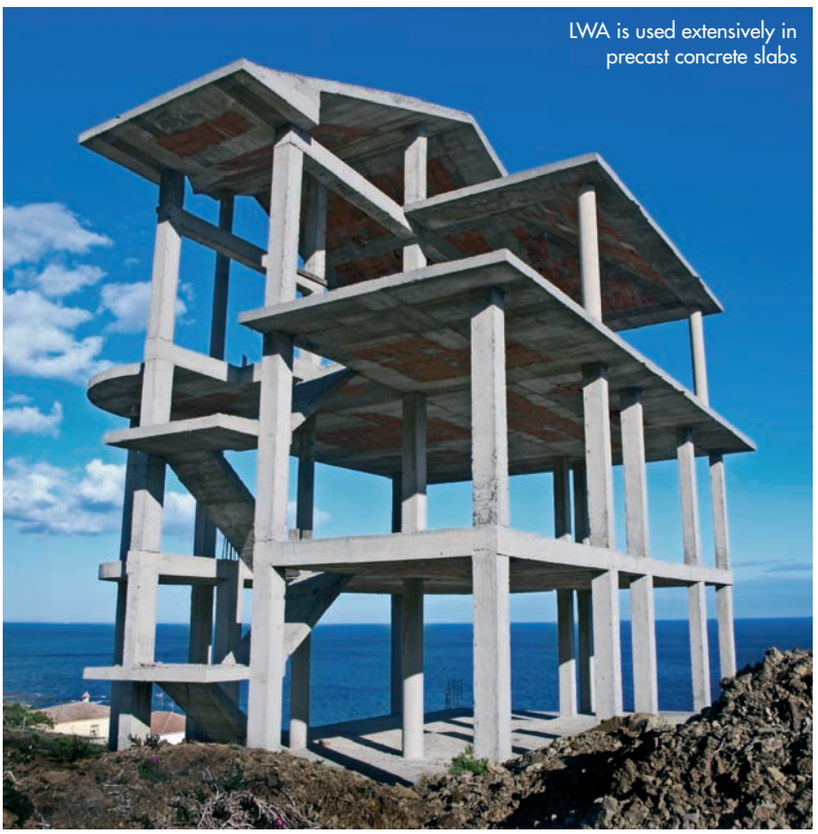
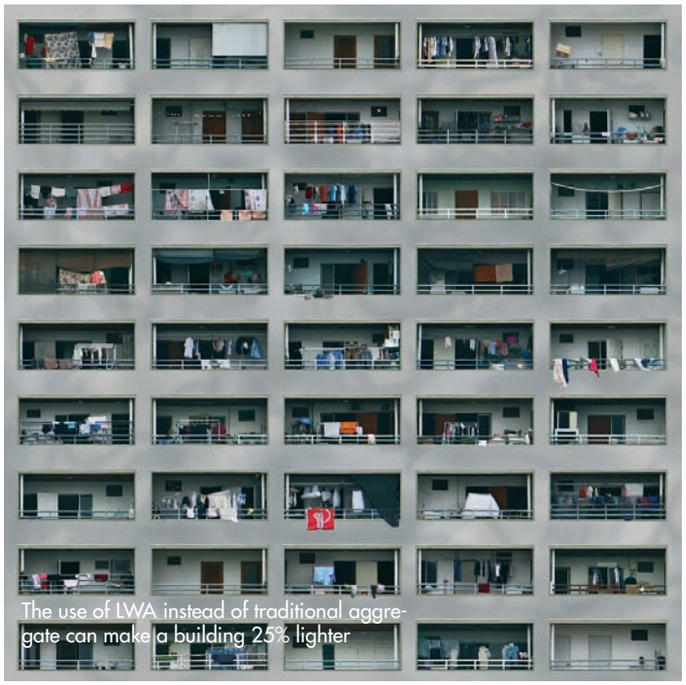
Miles of an 8-lane highway that could be built with the concrete used to build Chicago's Sears Tower

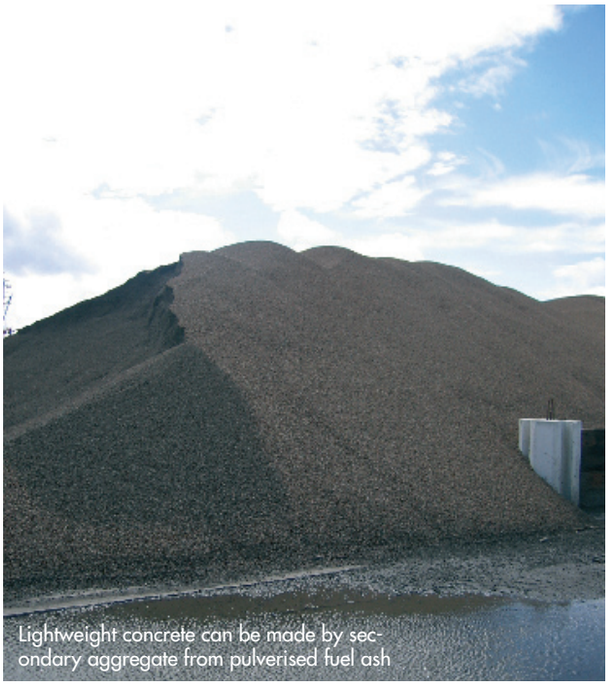


LWA is used extensively in precast concrete slabs

GLOBAL PLAYERS IN LIGHTWEIGHT CONCRETE

- **Bena German Emarati Co.** www.bena.ae
- **Lytag** www.lytag.co.uk
- **Foam Lite Concrete** www.foamlite.com
- **BASF Construction** www.basf.com
- **Johnson Concrete** www.johnsoncmu.com
- **APEX Precast** www.apexbuildingsystems.com
- **RAK Precast** www.rakprecast.com
- **Saudi Concrete Products Co.** www.saudiconcreteproducts.com
- **Cellufoam Concrete Systems** www.cellufoam.com
- **Aercon AAC** www.aerconaac.com
- **Masa Group** www.masa-ag.com
- **Dubai Precast** www.dubaiprecast.ae
- **EABASSOC** www.eabassoc.co.uk
- **Allied Foam Tech Corp.** www.alliedfoamtech.com
- **Propump Engineering Ltd** www.foamedconcrete.co.uk


The use of LWA instead of traditional aggregate can make a building 25% lighter


Lightweight concrete can be made by secondary aggregate from pulverised fuel ash

70 N/mm2
Strength of lightweight concrete using secondary aggregate.

For those architects and engineers designing tall buildings, material choice is a key opportunity to simultaneously tick the sustainability box and realise new design possibilities. Concrete is one building material where a number of options are available and the difference between them is significant.

The versatility, durability and cost-effectiveness of the material make it a key component in today's built environment and building tall is no exception. The 2009 CTBUH study serves as proof of such benefits, demonstrating how the trend for preferred material use is shifting from steel to concrete because of its flexibility.

Progress in materials technology, engineering and construction methods have made it possible to build taller in concrete over recent years, and some of the world's highest profile tall buildings serve as evidence of this growing trend.

Saudi Arabia's Makkah Clock Royal Tower Hotel is a concrete structure that will reach 577 metres when it finishes in 2012. The Sears Tower in Chicago (442 metres tall) contains enough concrete to build an eight-lane highway five miles long and New York City's World Trade Centre complex (built in 1970-71) used enough concrete to lay a pavement five feet wide from New York City to Washington—a distance of 204 miles.

As it is such a common material in construction, choosing the appropriate concrete to suit a project's requirements presents a prime opportunity to meet both design and sustainability challenges.

LIGHTWEIGHT AGGREGATE

The sustainability advantages of using secondary aggregate to make lightweight concrete are twofold: First, using the material avoids the quarrying of natural materials as it can be made from a variety of materials including colliery spoil, china clay waste, and power station ashes. For example, Lytag LWA is manufactured by sintering pulverised fuel ash (PFA), the by-product of coal fired power stations.

Second, using secondary aggregate diverts waste material from diminishing landfill resources, a particularly important initiative in making construction more sustainable. In June 2008, for example, the UK government introduced a target of halving the amount of construction, demolition & excavation waste currently sent to landfill by 2012. Put simply, this will be impossible without careful and efficient use of materials. Moreover, one of the stipulations for developing London for the 2012 Olympic Games is that 25% of the aggregates used must be recycled.

Using LWA in place of traditional aggregate can make a significantly lighter concrete—with some products, the result can be approximately 25% lighter without sacrificing structural integrity.

LWA is well known for use in a variety of construction applications such as screeds, fills, precast and structural concrete, which provides architects, engineers and contractors with the flexibility to build structures and achieve shapes that would

be unachievable with heavier material. Moreover, greater spans can be achieved and the number and width of columns can be reduced as lighter floors require less support. End-users can enjoy maximum floor space, while building owners benefit from additional square footage which can be of great commercial value.

CAPABILITIES & STANDARDS

Secondary aggregate can be used to make lightweight structural concrete, with oven dry densities that hover in the neighbourhood of 1750kg/m3 and strengths that exceed 70N/mm2.

It is also common for LWA to be used in precast concrete, from smaller concrete products such as lintels, posts and street furniture, to large scale commerical and residential units to infrastructure projetcts such as bridges and stadia.

Advances in admixture technology and tailored aggregate gradings have resulted in the availability of a wider range of concretes made using secondary aggregate, providing architects and structural engineers with myriad options to consider.

Design requirements for lightweight concrete are included in the new Eurocode 2 (EN 1992 1-1) which, in 2008, replaced the BS8110 Code of Practice for the design of structural concrete. The concrete standard, EN 206-1, provides guidance on the use of lightweight aggregate concrete, specifically with regard to strength and density which range between 800kg/m3 and 2000kg/m3.

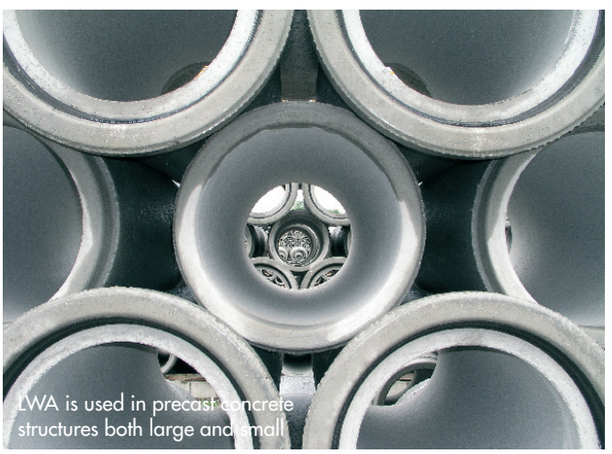
Pumpable and self compacting lightweight concrete, using both coarse and fine LWA, can be produced with oven dry densities in the region of 1450kg/m3 and strengths in excess of 40N/mm2.

As a result of such developments, even greater weight reductions of around 35% can be achieved by combining coarse and fine LWA. The architectural and design options available because of these technological advances would not be feasible with traditional concrete, which makes the material an especially attractive option for architects looking to build tall.

Versatility and sustainability of materials are both important factors in tall building construction, particularly as the expectation for innovative designs and taller structures is coupled with greater demand for 'greener' buildings.

Quick wins such as using concrete made with lightweight, secondary aggregate can allow project teams to build more sustainably, whilst offering opportunities to make those tall building designs evermore striking and innovative.

The use of LWA allows for fewer columns and greater spans



LWA is used in precast concrete structures both large and small

CASE STUDY: THE SWISS RE BUILDING, LONDON

Using LWA in concrete is a proven practice and many high profile buildings have benefited from the performance and sustainability advantages of using it.

One example is the Swiss RE building—The Gherkin—which opened in 2004. Developed by Swiss Re and designed by Foster + Partners, the 40-storey building has been designed to appear less bulky than other buildings of a comparable size. Using LWA not only enabled the tapered shape of the building to be structurally feasible, but also boosted the sustainability credentials of the project, which specified recycled materials whenever possible.

For the Gherkin, and for many of the other structural projects at Canary Wharf—many of which utilised Lytag LWA—choosing the material has played a major role in helping the building meet their design and environmental objectives.