(Photos: Lytag Ltd.)

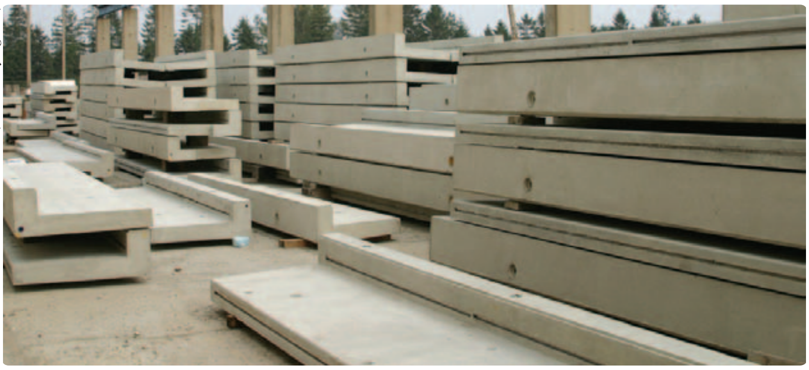

Figure 1: LWA precast components for Centre Court.

Showcase stadiums made with LWA concrete

As an opportunity to showcase architectural innovation on a large scale, the design and construction of stadiums and arenas are frequently a focus of media attention. This article looks at how lightweight concrete can help project teams to deliver these projects in a time-, cost- and resource-efficient way.

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"As use of the material in the redevelopment of Wimbledon Centre Court demonstrates, using secondary LWA in building sporting arenas offers a raft of benefits, including the potential for considerable time and cost savings."

Wembley Stadium, the Beijing 'Bird's Nest', Estadio Azteca, the Dallas Cowboys Stadium – building a new sporting arena provides an opportunity to create something spectacular, to demonstrate true innovation and to make an impression on an international stage. Designs can be exciting and dramatic, showcasing architectural talent as well as specialist engineering and construction techniques on a huge scale. However, as the world watches, the pressure is on to deliver an impressive structure on time, within budget, and in a sustainable way.

The preference for concrete in building the London 2012 Olympic Stadium reflects an ever-growing appreciation of the capabilities and versatility of the material. As such, a key component in the building of a stadium, namely choosing the right concrete for the project, can have a real impact on the project's timeframe, costs, and sustainability credentials. Using lightweight concrete, made with lightweight aggregate (LWA), can allow benefits in all these areas.

Using LWA in the place of traditional aggregate creates a significantly lighter concrete – using Lytag LWA for example makes a concrete approximately 25% lighter but while still maintaining the same structural integrity. This can open up design possibilities as it helps overcome restrictions caused by concrete's dead weight, enabling stadium construction project teams to deliver a structure that would be unachievable or require design or time-scale compromises with heavier material.

The time savings that use of lightweight concrete can offer a stadium construction project are considerable, as the lighter structure requires less supporting construction, and the material is easier to transport and handle. Keeping strictly to the build progamme is essential for a stadium construction project to ensure the arena is ready for use for specific sporting events. In the current economic climate, the revenue from hosting sporting or other events is crucial – the more quickly a stadium is ready for use, the more quickly these events can be held.

Lightweight, secondary aggregate can be used to make structural lightweight concrete, with oven-dry densities in the order of 1750kg/m^3, and strengths exceeding 70MPa, achievable using lightweight coarse aggregate and natural sand. 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 units for bridges and stadiums. Lytag lightweight coarse aggregate provides a weight saving of around 25% over normal-weight precast concrete, leading to real advantages in production techniques, reduced fixings, logistics and crane requirements, and by combining both coarse and fine LWA, even greater savings are possible.

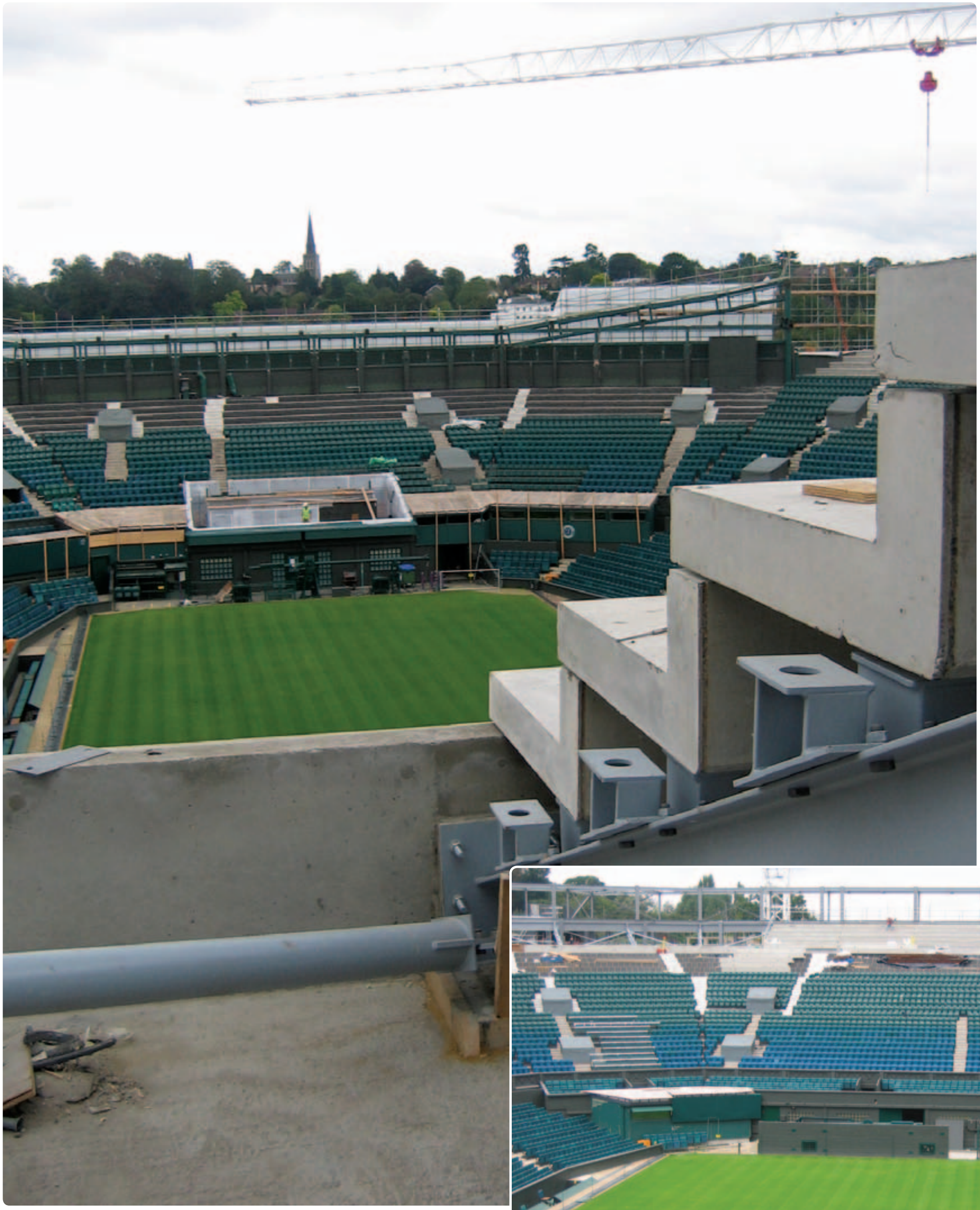
Advances in admixture technology and tailored aggregate gradings have resulted in the availability of a wider range of concretes made using secondary aggregate, providing architects and structural engineers with a greater selection to consider. Design requirements for lightweight concrete are included in the new Eurocode 2 (EN 1992-1-1[(1)]), which in 2008 replaced the BS 8110[(2)] *Structural use of concrete*. The concrete Standard, EN 206-1[(3)] provides guidance on the use of lightweight aggregate concrete, specifically with regard to strength class and density class, which range between 800kg/m^3 and 2000kg/m^3. Pumpable and self-compacting lightweight concrete, using both coarse and fine lightweight aggregate, can be produced with oven-dry densities in the region of 1450kg/m^3 and strengths in excess of 40MPa. As a result of such developments, even greater weight reductions of around 35% can be achieved by combining coarse and fine LWA. The opportunities that this offers for innovation of design and engineering, that would not be feasible with traditional concrete, make the material an attractive option for clients and their project teams building a stadium.

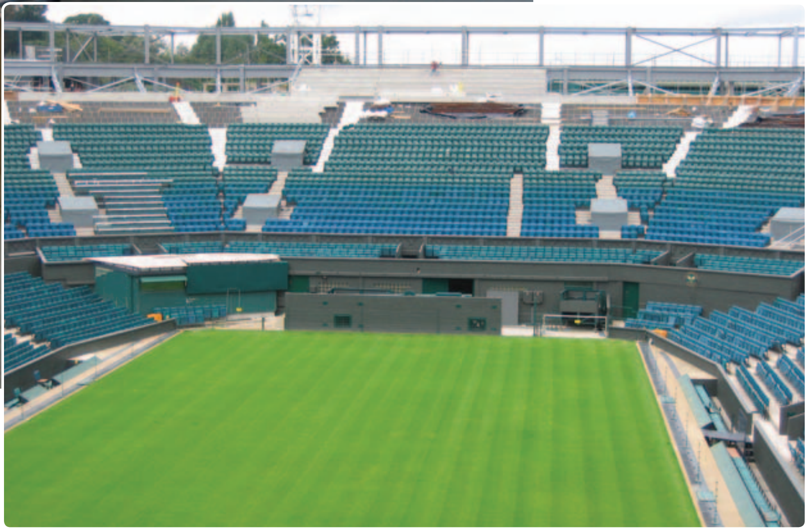
Of course, design innovation and project time frame are not the only considerations for those building a stadium. Another is the sustainability agenda – government legislation and client demand continue to drive the construction industry to reduce its environmental impact. As recognition grows among clients and their supply chain alike that sustainable working practices can lead to cost savings, lowering a project's environmental impact and using resources efficiently are now more important than ever before. Replacing traditional aggregate with secondary aggregate is a simple way to make concrete, and construction, more sustainable. Lytag LWA, for example, is a secondary aggregate manufactured from the fly ash produced by coal-fired power stations so it not only diverts ash from landfill but also reduces the demand on quarried aggregate.

Tried and tested

Concrete made with LWA has been used in many high-profile stadiums and arenas, including Wimbledon Centre Court. In 2006, a project was launched to expand the famous Centre Court and build a retractable roof to allow play during increasingly wet summers.

Building within an existing structure, especially one of Centre Court's calibre, is undoubtedly more challenging for designers and structural engineers than working with a





Figures 2 and 3: Construction work at the new Wimbledon Centre Court.

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blank canvas. The structure and its foundations must be able to carry the weight of the extension, or significant work to strengthen the existing building would be needed. This was the case when architects were looking to add a further six rows of seating on the east, north and west sides of the 13,000-seater stadium to take capacity to 15,000.

Galliford Try, the contractor appointed by the All England Lawn Tennis Club, chose to use Tarmac to manufacture the precast concrete units, which used Lytag LWA. By specifying concrete made using Lytag LWA, it was possible to produce units that are around 25% lighter than would have been achievable by using traditional concrete. As a result, the contractor did not need to undertake support work to the surrounding structure. Hence, the overall weight of the extension, which also covered the press boxes, media office, changing rooms and committee rooms situated below, was significantly reduced.

As use of the material in the redevelopment of Wimbledon Centre Court demonstrates, using secondary LWA in building sporting arenas offers a raft of benefits, including the potential for considerable time and cost savings. As a simple way to achieve these benefits while simultaneously improving a project's sustainability credentials, this is an approach that the industry would do well to embrace. ■

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