

Lightweight aggregate has design benefits

Much is expected of 21st Century architecture – buildings are bigger and better than ever before and both space and time have become increasingly precious. Efficient use of space, impressive aesthetics, and serving specific occupancy needs are just some of the requirements that clients expect architecture to meet.

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At the same time, Government legislation and targets are driving the industry to build in a greener way from the very outset of a project. For example, recent proposals to update the Construction Products Regulations in the UK would see architects required to consider the sustainability of the products they specify.

Additionally, new considerations such as the possibility of extreme weather and terrorist attacks are continually added to the list of factors that today's architects and structural engineers are asked to take into account when developing a design. It is undoubtedly a complex challenge but there are solutions available that can help architects and engineers comply with both client and Government demands within tight timeframes. One of these approaches is material choice. For concrete this involves selecting a type that will suit a project's requirements and will also tick the sustainability box.

Secondary aggregate in concrete

In architecture, weight is a crucial consideration and the high dead-weight of traditional concrete can be especially limiting. Using secondary aggregate, manufactured from materials such as pulverised fuel ash (PFA), can create concrete that weighs significantly

less than that made with natural aggregate, but still offers the same structural integrity. This combination can allow architects to deliver on a variety of fronts including design innovation and sustainability. For instance, concrete manufactured using Lytag secondary aggregate offers a 25% weight reduction over traditional concrete so architects and structural engineers can access some significant design benefits. These can include larger structures and greater spans, and a reduced number and size of columns because the lighter floors need less support. Ultimately, building owners and occupiers can enjoy maximised usable floor space – additional area that can be of great commercial value.

Lightweight aggregate concrete (LWAC)

Secondary aggregate can be used to make structural LWAC, with oven-dry densities in the order of 1750kg/m³, and strengths exceeding 70MPa, achievable using lightweight coarse aggregate and natural sand. It is also common for lightweight aggregate to be used in precast concrete, from smaller concrete products such as lintels, posts and street furniture, to large-scale units for bridges and stadia. Lytag lightweight coarse aggregate provides a weight saving

of around 25% over normal-weight precast concrete, leading to advantages in production techniques, reduced fixings, logistics and crane requirements, and by combining both coarse and fine lightweight aggregate even greater savings are possible.

Advances in admixture technology and tailored aggregate gradings have resulted in a wider range of concretes made using secondary aggregate being available, providing architects and structural engineers with a greater selection to consider. Structural LWAC is a widely accepted alternative to normal-weight concrete (NWC) and design requirements are included in the new Eurocode 2 (BS EN 1992-1-1)⁽¹⁾. The concrete Standard, BS EN 206-1⁽²⁾, provides guidance on the use of lightweight aggregate concrete, specifically with regard to strength class and density class which range between 800kg/m³ and 2000kg/m³. Pumpable and self-compacting LWAC, using both coarse and fine lightweight aggregate, can be produced with oven-dry densities in the region of 1450kg/m³ 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 lightweight aggregates. This lighter-weight concrete offers opportunities for architectural innovation and design that



Figure 1: Buildings making up the London skyline have enjoyed greater flexibility of design by using lightweight aggregate.



Figure 2: Heathrow Terminal 5 has chosen to use lightweight aggregate.

would not be feasible with traditional concrete.

The Swiss Re building

Concrete made using lightweight secondary aggregate has allowed for innovative designs and enhanced sustainability credentials in the construction of many of the UK's landmark structures – 'the Gherkin' is just one example. De-veloped for Swiss Re and designed by architect Norman Foster of Foster and Partners, the 40-storey Gherkin building opened in 2004. It has been designed to appear less bulky than other buildings of a comparable size, and this was facilitated in part by choosing concrete made using secondary aggregate. The lighter weight enabled the distinctive tapered shape of the building to be structurally feasible and using the secondary material boosted the sustainability credentials of the project, which specified recycled materials wherever possible. The structural concrete in the 180m-high tower was made using 4–12mm Lytag coarse aggregate (now 4/14mm), and 4/8mm Lytag was used for no-fines screeds.

From Wimbledon Centre Court to Heathrow's Terminal 5, Lytag has been used to help meet design and environmental objectives in a variety of structural projects. For many of



Figure 3: Precast concrete units.

these, as well as for the Gherkin, it is the material's lightweight quality coupled with the additional performance benefits – such as improved thermal and insulation properties – that have played a major part in allowing architects and engineers to fulfil both client and Government requirements.

Environmental credentials

One such requirement that has risen high up the construction industry's priority list over recent years is sustainability. Government legislation and targets such as halving the amount of construction waste sent to landfill by 2012, a goal set out in the 2008 Strategy for Sustainable Construction, are driving the industry towards a more sustainable future. There is a role for everyone to play, from client and designer to structural engineer and contractor. Using secondary aggregate in

concrete is one way for the industry to work towards meeting sustainability targets, as using a sustainable material reduces the demand for natural quarried aggregate, and also diverts significant amounts of waste from landfill each year.

Conclusion

Both the versatility and the sustainability of materials are important factors for today's architects and structural engineers, particularly as the expectation for more innovative designs and taller structures is coupled with greater demands for 'greener' buildings. Using concrete made with lightweight, secondary aggregate can make a building more sustainable, while also offering opportunities for design that can take architecture forward in delivering innovation and efficiency. ■

References

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