LYTAG®
lightweight solutions

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CI/SfB (-A) Eq7	

Technical Manual – Section 2
Introduction to Lytag® lightweight aggregate concrete - LWAC

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Introduction

Lytag lightweight aggregate (LWA) is specifically designed and manufactured to meet all the requirements of modern construction practice, whilst overcoming the prime disadvantage of concrete - its weight. Structural concrete, with compressive strengths in excess of 60 MPa can be produced with an effective reduction in dead load of approximately 25% over normal weight concrete. This means that considerable savings can be made in foundation and reinforcement costs. In addition, column, beam and slab sizes can be reduced thus saving in overall concrete volume and giving wider opportunities in design.

Notes

- For all the following mixes the characteristics of the cement, fine aggregate and the degree of quality control are outside the scope of Lytag Ltd. It is therefore recommended that the concrete producer confirm the mix performance by carrying out appropriate trials.
- It is common practice for contractors to arrange a meeting with the consultant, the ready-mix supplier (where applicable) and our representative before concreting commences on site. Visits to contracts where Lytag LWA is being used can usually be arranged for contractors and consultants who intend to use Lytag lightweight aggregate concrete (LWAC).
- There are moderate variations in the bulk density of the Lytag LWA, the value of which can be checked with the Lytag Ltd sales office.

Overview of Lytag LWA Concrete

Lytag LWA supplied to BS EN 13055 can be used in lightweight aggregate concrete (LWAC), which is designed in accordance with BS EN 206 – I and BS 8500.

Lytag LWAC is most economical when the dead weight is large compared with the total load or when a low density is required. In these circumstances, the load bearing capacity of the LWAC will be equivalent to or even higher than normal weight concrete, as a proportion of the total loading. The reduced dead load can have a significant effect upon the cost of formwork and scaffolding (floor slabs, bridges etc.,) and the saving of foundation costs in high-rise structures and where bad ground conditions prevail, can be appreciable. In tall buildings, the dimensions of columns, particularly in the lower storeys, can be considerably reduced and generally an overall reduction can be made in the amount of steel reinforcement required.

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When Lytag LWAC is used for precast elements, these tend to be cheaper to transport and easier to handle on site. Improved fire resistance, heat insulation and frost resistance are additional benefits to be gained from using Lytag LWAC.

General Guidelines

The oven dry loose bulk density of the Lytag lightweight coarse and fine aggregate should be checked with the Lytag Ltd Office. As a guide 0.79Mg/m^3 can be used for the lightweight coarse and 1.00Mg/m^3" for lightweight fine aggregate.

Lytag LWA rapidly absorbs approximately 15% of its own weight in water. This must be is allowed for in the mix design and batching to ensure that the correct volume of water is added.
For more detailed advice on Lytag LWAC mixes, it is recommended that you contact the Lytag Ltd technical sales team.

Normal tolerances in consistence/ flow classes the workability are permissible. If the mix adjustment procedure has been followed, then little further absorption should occur. If however, loss of consistence occurs during transportation it will usually be permissible for controlled addition of water on site. It is important to note that this additional water will not affect the effective water/ cement ratio of the concrete as it is replacing the effective water absorbed into the cellular structure of the aggregate. Figure 1 shows typical absorption rate of Lytag 4/14mm.

The moisture content of the fine and course aggregate should be determined prior to mixing. (If a “Speedy” moisture test is to be used, the coarse aggregate should be partially crushed). After the dry batch weights have been adjusted, dependent upon the aggregate moisture contents, additional water should be added to the mix to compensate for the water absorption by the Lytag LWA particles. This is essential to satisfy the requirements of cement hydration and specified consistence/ flow class workability. The calculation of how much water to add is set out in the Batch Weight Calculation table in section 5 of the Lytag Technical Manual.

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During spells of dry weather conditions, it will be advantageous to dampen the aggregate with water 24 hours before use to reduce the effects of absorption. This is particularly advisable where Lytag® LWAC is to be placed by pump. Lytag LWAC mixes can be used successfully with cement replacement material such as pfa and GGBS. By introducing these materials further enhancements in the properties of the concrete can be made. These include:

- Reduction in the heat of hydration, further reducing the risk of thermal cracking in thicker sections.
- Additional resistance to sulfate forms of chemical attack
- Reduction in the permeability of the hardened concrete
- Increase in long term strength gain
- Reduction in Chloride penetration further protecting any steel reinforcing
- Reduced environmental impact

Water reducing and stabilizing are recommended for use in Lytag LWAC admixtures should be used in Lytag LWAC mixes. The inclusion of chemical admixtures can enhance fresh and hardened concrete properties

The mix proportioning and consistence class of all the mixes in Section 3 of the Lytag Technical Manual are indicative only. They are subject to other material properties characteristics outside the control of Lytag Ltd.

Lytag LWAC has been placed by pump for many years. Flexibility regarding mix proportioning and target flow needs to be exercised. The possibility of increased pressures in the pump pipeline, particularly in high-rise situations, could conceivably lead to blockages due to water absorption of the Lytag LWA. Lytag recommend Pre-wetting the aggregate 24 hours prior to batching to reduce this effect. Reference can be made to Lytag Ltd technical sales team, who can advise on matters relating to structural concrete.

Additional Specialist Applications

Bridges

BS 5400: Part 4 permits the use of Lytag LWAC in the construction of reinforced concrete bridges. Lytag LWAC has advantages for bridge building where the dead load plays a dominant role in relation to the total loading. For bridge decks considerable cost savings can begin with spans of 15-20 metres. With spans of 30 metres the proportion of dead weight and live load are approximately equal. At 50 metres the proportion of dead load increases to 60% and at 100 metres to 80%.

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When using Lytag LWAC the weight saving for 50 metre spans is about 18% and for 100 metre spans about 24%. With the same dimensions the bending moments and pre-stressing reinforcement can also be reduced by the same percentages. Since stresses are proportionally decreased, it is possible to use Lytag LWAC with a lower strength requirement than that of natural aggregate concrete or, alternatively, use smaller members and save on cost of materials and handling.
The reduction in weight not only results in savings in supporting structures and formwork, but also throughout the structure, in piers, foundations and piling.

The Design Manual for Roads and Bridges, BD 57/01 states that improvements to durability can be made using lightweight aggregate concrete,and Clause 2.1 states that continuous bridges are the most durable.

The coefficient of thermal expansion of Lytag LWAC is lower than for normal weight concrete and for practical purposes can be taken at 7x10-6 /oC.

There are many cases worldwide where lightweight aggregate concrete has been successfully used in bridgeworks as a complete structure or in composite construction.

Marine Structures

Coupled with being an extremely durable material, Lytag LWAC is ideal for use in marine structures such as bridges and oil installation structures. This durability, combined with low density and high strength allows structures like oil storage facilities to be constructed using Lytag LWAC. At Hunterston, the savings in weight for a gravity base oil storage structure meant that the preferred dry dock could be used without having to be dredged for extra depth. This significantly reduced the cost of the project. As well as having to withstand the North Sea environment the base has to act as a storage tank for an acidic oil. Other marine structures such as pontoon bridges and seabed pipeline protection have been constructed in Lytag LWAC.

In the USA and Canada lightweight concrete has also been used for over 40 years on bridge construction in the marine environment and in pontoons and jetties. Lightweight aggregate concrete was also used in the concrete ship building programme during the two world wars. One such ship, the USS Selma launched in 1919, and permanently immersed in sea water, was the subject of extensive tests in 1980 that showed no significant deterioration of the lightweight concrete or the reinforcing steel although the cover to the steel was only 16mm.

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The use of Lytag LWAC in marine and offshore structures presents the designer with a much larger range of concrete properties than is possible with a natural aggregate concrete.

- Additional buoyancy can be achieved by the use of a lower density concrete.
- Ratio of dead load to superimposed load (or potential cargo load) is more advantageous.
- Lytag LWAC exhibits better crack resistance from shrinkage, creep and thermal expansion movements.
- Lytag LWAC has better energy absorption characteristics from impact and cyclic loading.
- Lytag LWAC has better insulation, cryogenic and fire resistant properties.
- Lytag LWAC in construction can show savings in transport, craneage, formwork, concrete placement and plant maintenance.
- Lytag LWAC is easier to drill, fix into, or cut, offering little deflection to the tools used.

Water Retaining Structures

Lytag LWAC is ideal for use in Water Retaining Structures. Cracking due to temperature and moisture changes is minimised, contraction and curing properties presents few, if any, problems and an impermeable concrete can be produced.

Water storage dams are required to possess the same basic qualities as a water retaining structure (see section above). The sheer scope of the work frequently involves the placing of very large volumes of concrete where problems associated with the control of thermal movements and effective curing are ever present. Lytag LWAC has a lower coefficient of thermal expansion (see relevant section) and exhibits more efficient curing characteristics (see relevant section). The incorporation of cement replacements in the mix would enhance the durability of the concrete and would further help reduce any movement due to thermal stresses.

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Pipe Coating

Concrete is used as a coating on subsea pipelines to provide mechanical protection and stability. However, in some situations, a normal weight concrete design may be too heavy to meet conditions required for laying the pipes. In these instances Lytag LWAC can offer the mechanical protection required with the optimum pipe weight for safe and efficient laying.

References

BS EN 13055-1 Lightweight Aggregates – Lightweight aggregates for concrete, mortar and grout

BS EN 206-1 Concrete – Specification, performance, production and conformity

BS 8500-1 Concrete – Complimentary British Standard to BS EN 206-1. Method of specifying and guidance for the specifier

BS 8500-2 Concrete – Complimentary British Standard to BS EN 206-1. Specification for constituent materials and concrete

Lytag Technical Manual, Section 3 - Mix designs
Lytag Technical Manual, Section 5 - Manufacture of LWAC using Lytag LWA

BS 5400-4 Steel, concrete and composite bridges. Code of practice for design of concrete bridges

Design Manual for Roads and Bridges Volume 1 Highway Structures. Approval procedures and general design, section 3 general design, part 7, BD 57/01 Design for durability

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