Uniclass L331:P224	EPIC C311:X223
CI/SfB Eq7	

LYTAG®

Technical Manual - Section 4

Design Guidance for Lytag® LWAC (Concrete)

General Design Guidance 2
- **Workability** 2
- **Water content** 2
- **Placing and compacting** 3
- **Curing** 3
- **Bay sizes** 4
- **Strength gain of Lytag® LWAC** 4
- **Fixings into Lytag® LWAC** 4
- **Cold weather concreting** 4
- **Impact** 5
- **Durability** 5
- **Alkali Silica Reaction (ASR)** 6
- **Carbonation** 6
- **Thermal Conductivity of Lytag® LWAC** 6
- **Cryogenic Conditions** 7
- **Water Permeability** 7

Design of Lytag® Lightweight Aggregate Concrete 8
- **Strength and Density Class** 8
- **Shear resistance** 9
- **Punching shear of slabs** 10
- **Detailing** 11
  - *Maximum bar size* 11
  - *Bend diameters* 11
  - *Bond and anchorage* 11
- **Fire resistance** 11
- **Durability and cover to reinforcement** 12
- **Modulus of elasticity** 13
- **Elastic deflection** 13
- **Creep** 14
- **Drying shrinkage** 15
- **Poisson's ratio** 15
- **Coefficient of thermal expansion** 15

Lytag Ltd. 4 Bramley's Barn, The Menagerie, Escrick, North Yorkshire, YO19 6ET
Company registration number 6005140

Lytag® is a registered trade mark of Lytag Ltd.

General Design Guidance

Workability

Lytag® lightweight aggregate concrete (LWAC) skip mixes are generally designed around a BS 8500-1:2006 S2 consistence class (50mm – 90mm) or a target slump of 70mm.
To pump Lytag® LWAC mixes requires the use of admixtures and an appropriate mix design to produce a semi-flowing concrete equivalent to BS 8500-1:2006 flow class F5 or target flow of 560–620mm. It is important that monitoring is carried out to ensure the correct workability of the concrete discharge into the pump. However when pump pressures are high, it may be necessary to increase the target flow to compensate for loss of consistence.
If the workability is low prior to discharge, this is either due to insufficient water at the time of batching or absorption of water by the Lytag® lightweight aggregate (LWA). It is important that if water is added to achieve the specified workability, it is done in a controlled manner and within the time allowed for placing the concrete and should not affect the hardened properties of the lightweight concrete, i.e. strength and durability.

Water content

Lytag® LWA is a highly absorbent material with a water absorption of around 15%. An allowance must be made for the absorbed water when calculating the final concrete batch weight. The consistence of the fresh concrete must be such that it can be easily compacted to the required density and the quantity of added water required at the mixer should be determined by full-scale trials.
Most of the aforementioned water absorption will occur in the first few minutes following batching and can therefore be controlled at the mixing plant. However, the Lytag® LWA may continue to absorb water, albeit at a much slower rate during transportation, with a resulting loss in consistence.
If this creates difficulties in placing, it is desirable that the level of consistence is increased to that specified and this is usually achieved by the controlled addition of water on site. An acceptable site procedure should be established for the addition of water to bring the consistence back to that required. Care should be taken not to exceed the total allowable water content as this may compromise any specified free water/cement ratio required for durability.
The density and yield of fresh concrete are dependent on the free water content. When concrete has a reduced consistence, the yield will be reduced and density and strength increased. The converse will apply for increased consistence.

Lytag Ltd. 4 Bramley's Barn, The Menagerie, Escrick, North Yorkshire, YO19 6ET
Company registration number 6005140
Lytag® is a registered trade mark of Lytag Ltd.

Placing and compacting

There are no significant differences in concreting techniques for placing normal weight concrete and Lytag® LWAC. It should be vibrated as for normal weight concrete. Where a vertical surface requires a high quality finish and minimal blowholes, Lytag® LWAC may require slightly more vibration as it releases entrapped air more slowly due to the reduced hydrostatic head. However, care should be taken not to over-vibrate the concrete. Lightweight concrete with coarse and fine Lytag® LWA may have a tendency to bleed more than normal weight concrete resulting in clear bleed water appearing on the surface of slabs subsequent to vibrating and tamping. This bleed water should be allowed to evaporate prior to any further finishing operations taking place. Lytag® LWAC is readily placed by concrete pumps providing the concrete has the necessary pumpability and consistence characteristics.
Any 'pimpling' effect left on the surface after tamping and ruling off can be significantly reduced by floating the surface when the concrete has stiffened but whilst it is still semi-plastic. When a U1 finish is specified, a second pass, following the initial set, will be required. Provided sufficient mortar has been generated on the top of the concrete during the compaction process, the Lytag® LWAC can be powerfloat finished to produce a U2 finish by panning or floating or a U3 finish by trowelling.

Curing

As with all types of concrete an effective curing regime must be applied as soon as practically possible to prevent rapid loss of moisture, i.e. spray on curing membranes, polythene sheeting etc.
However, due to the water absorption properties of Lytag® LWA, Lytag® LWAC contains a reservoir of water, which can aid curing. This water is transferred to the matrix as evaporation takes place on the surface of the concrete. Thus, by continuous replacement, water for the hydration of the cement is automatically provided for a period of time dependent upon the ambient conditions. This action ensures a more complete and effective hydration of the cement takes place, improving concrete quality over normal weight aggregates. It should be noted that this is not a substitute for normal curing regimes.

Lytag Ltd. 4 Bramley's Barn, The Menagerie, Escrick, North Yorkshire, YO19 6ET
Company registration number 6005140
Lytag® is a registered trade mark of Lytag Ltd.

Bay sizes

Large bay sizes can be poured yielding higher overall production.
Suspended slab construction in Lytag® LWAC requires fewer expansion and construction joints, due to the following:

- Thermal movement due to heat of hydration is reduced due to the lower coefficient of expansion of Lytag® LWAC.
- Early drying shrinkage is reduced.
- The tensile strain capacity is higher.
- The elastic modulus is lower.

Strength gain of Lytag® LWAC

The rate of strength gain of Lytag® LWAC up to 28 days is similar to normal weight, natural aggregate concrete. Beyond 28 days, the strength gain for Lytag® LWAC with a strength class of LC35/38 or less is greater than natural aggregate concrete of equivalent strength. For concrete strength classes above LC35/38 the rate of strength gain is comparable or slightly better than the equivalent natural aggregate concrete. This however is dependent on the type of cement used in the concrete.

Fixings into Lytag® LWAC

Lytag® LWAC can be easily drilled or shot fired for reliable fixings. The rigidity and load bearing capacity of various fixings in Lytag® LWAC can be similar to that obtained in normal weight concrete. Due to the physical characteristics of a Lytag® LWA pellet, drilling and cutting work is easier and quicker, with appreciably less wear on tools.

Cold weather concreting

Lytag® LWAC has an improved thermal response compared to normal weight concrete. The specific heat of Lytag® LWAC is very similar to that of normal weight concrete which, combined with its lower density, gives it this advantageous property. These factors, together with the small increase in cement content of Lytag® LWAC, result in higher internal temperatures and consequently have less of a tendency to be damaged by frost during the first few days after placing. Thus it is generally possible to place Lytag® LWAC concrete at a lower air temperature than with normal weight concrete.

Lytag Ltd. 4 Bramley's Barn, The Menagerie, Escrick, North Yorkshire, YO19 6ET
Company registration number 6005140
Lytag® is a registered trade mark of Lytag Ltd.

Tests have shown that when comparing normal weight and Lytag® LWAC with the same cement contents, the temperature at 18 hours is about 10°C higher for the Lytag® LWAC. This results in:

- Better frost resistance during critical first 48 hours
- Higher compressive strength in the structure.

However, these advantages should be used to assist good site practice for cold weather concreting and not as a replacement for it.

Impact

The lower modulus of elasticity and the higher tensile strain capacity of Lytag® LWAC should result in improved resistance to impact loading.
There is little published data on this, but some experimental work with drop weight impact showed a small advantage to Lytag® LWAC against natural aggregate concrete and it is claimed that under pile-driving there is a reduction of 18% in maximum compressive stress and 22% in maximum tensile stress.

Durability

Durability expresses the property of concrete to remain intact during its effective life without significant change in its physical or engineering characteristics. An increase in the water/cement ratio affects the permeability and reduces both the protection to reinforcement and the resistance of the concrete to various modes of attack from the environment. The reduction of permeability therefore, is of major importance when considering the durability of a concrete.
Despite the greater porosity of Lytag® LWA the rate of movement of liquids through the concrete will be less than with natural aggregate concretes. This is due to the lower water/cement ratio, the reduced stress concentrations arising from the virtual absence of micro-cracking, the excellent aggregate/paste bond and the higher cement content. Also the increase in pore water results in a more complete, efficient hydration of the cement. The effects of heat generated by cement hydration are less damaging. The impermeability of Lytag® LWAC concrete can be further improved by the inclusion of cement replacements such as p.f.a. or GGBS as a part of the cementitious component.
Not withstanding the above, BS EN 1992-1-1 details for that LWAC the cover to reinforcement is increased by 10mm.
The Highways Agency specifies that, for bridges, cover shall be the nominal cover derived from BS5400: Part 4: Table 13 increased by 10mm.
It should be noted that as BS 5400-4 already makes provision for an additional 10mm of cover for lightweight aggregate concrete the requirement for the additional cover does not apply. This means that cover for normal weight concrete is to be the same as lightweight concrete.

Lytag Ltd. 4 Bramley's Barn, The Menagerie, Escrick, North Yorkshire, YO19 6ET
Company registration number 6005140
Lytag® is a registered trade mark of Lytag Ltd.

The durability requirements in BS 8500-1, *Concrete – complementary British Standard to BS EN 206-1*, do not differentiate between lightweight aggregate concrete and normal weight concrete. Thus for a given exposure condition, the same minimum compressive strength class based on cylinders (e.g. C40/50 and LC40/44) and associated maximum water/cement ratio and minimum cement or combination content will apply.

Alkali Silica Reaction (ASR)

In accordance with BRE Digest 330, sintered pfa, Lytag® LWA, is considered to be of low reactivity. The guidelines given in Digest 330 Part 2 should be followed to minimise the risk of damaging ASR in new construction.
This could entail replacing a high reactivity aggregate with Lytag® LWA to reduce the risk of ASR occurring.

Carbonation

Experience shows that under normal conditions, well compacted, impermeable concrete can effectively protect reinforcement against corrosion, provided that the cover is adequate. This protection depends upon the alkalinity of the cement matrix, for in alkaline solutions with pH values of 11-13, steel will not corrode. Hydrating cement normally provides the concrete with a pH value of about 12.5. The higher cement content associated with Lytag® LWAC tends to produce a less permeable matrix, hence reducing the depth and rate of carbonation. In order to offset the slightly lower resistance of Lytag® LWAC against gas diffusion, concrete cover to reinforcement should be in accordance with BS EN 1992-1-1.

Thermal Conductivity of Lytag® LWAC

The thermal conductivity values given in table 1 are extracted from the CIBSE Environmental Design Guide A.

Table 1 Thermal Conductivity

Density (kg/m^3)	Thermal conductivity – λ – ($W \cdot m^{-1} \cdot K^{-1}$)
1600 - 1800	0.85 – 1.13

(At 3% moisture)

Lytag Ltd. 4 Bramley's Barn, The Menagerie, Escrick, North Yorkshire, YO19 6ET
Company registration number 6005140
Lytag® is a registered trade mark of Lytag Ltd.

Cryogenic Conditions

Concrete generally performs well at very low temperatures but the containment properties of Lytag® LWAC have been found to be significantly better than natural aggregate concrete. Permeability coefficients have been found to be two orders of magnitude lower and crack resistance (strain capacity) is approximately doubled.

Water Permeability

The durability of any concrete in aggressive environments is dependent upon its permeability. This determines the rate that aggressive soluble chemicals enter the concrete.
Excessive free water/cement ratios can allow greater capillary action resulting in water penetration. Thermal and shrinkage cracking can also allow the ingress of moisture.
In Lytag® LWAC there are a number of factors that combine to reduce the chance of moisture ingress:

- The higher cement contents together with lower free water / cement ratios considerably reduce capillary action.
- The lower coefficient of expansion reduces thermal movement due to heat of hydration.
- The high tensile strain capacity together with the low elastic modulus and reduced early drying shrinkage combine to minimise the risk of cracking.
- The surface of Lytag® LWA is rough, giving an excellent bond with the matrix in the contact zone.

The high water absorption of the aggregate allows moisture to be available for longer within the matrix, thus leading to a better, more complete, hydration of the cement. This leads to a higher quality of concrete hence permeability is reduced and durability improved.

Lytag Ltd. 4 Bramley's Barn, The Menagerie, Escrick, North Yorkshire, YO19 6ET
Company registration number 6005140
Lytag® is a registered trade mark of Lytag Ltd.

Design of Lytag® Lightweight Aggregate Concrete

Structural design of Lytag® LWAC should be in accordance with BS EN 1992-1-1, Eurocode 2: Design of concrete structures, General rules and rules for buildings and the UK National Annex. Section 11 of the BS EN 1992-1-1 covers Lightweight Aggregate concrete structures. It should be noted that some of the design approaches adopted differ from those in earlier design standards, such as BS 8110, Structural use of concrete. Guidance on the use of Eurocode 2 may be found in How to design concrete structures using Eurocode 2 and the design of simple structures is covered by the Concise Eurocode 2.
The design parameters set out below form an outline only and should be read in conjunction with the British Standards.
Values referred to in this document are taken from the Eurocode standards, however if more accurate values are available they should be used
Note - This Technical Manual uses decimal points rather than adopting the Eurocode approach, which uses commas, and where MPa is used this is equivalent to N/mm^2.

Strength and Density Class

In line with EN 206, Concrete, and BS 8500, Concrete – complementary British Standard to BS EN 206-1, lightweight concrete is defined in terms of its strength class, e.g. LC30/33, indicating a characteristic cylinder strength of 30MPa and a characteristic cube strength of 33MPa. (Note that the assumed difference between the cylinder and cube strengths for lightweight concrete is less than for a normal weight concrete, which would be C30/37 in this case.)
An important point to note is that in BS 8110, design was based on concrete cube compressive strengths and so the equivalent lightweight concrete strength would reflect the cube strength, i.e. C30 normal weight concrete would equate to a C30 lightweight concrete. In the Eurocodes, design is based on cylinder strength, hence the equivalent strength class would be based on the cylinder strength, i.e. C30/37 would become an LC30/33
Additionally, lightweight concrete is defined by its density, see Table 2. Concrete using coarse Lytag® LWA and natural fine aggregate should be assumed to be Density Class 1.8 and concrete using both coarse and fine Lytag® LWA should be assumed to be Density Class 1.6. Also shown in the Table are the assumed densities of plain and reinforced concrete (with normal percentages of reinforcement) to be used in calculating self-weight.

Lytag Ltd. 4 Bramley's Barn, The Menagerie, Escrick, North Yorkshire, YO19 6ET
Company registration number 6005140
Lytag® is a registered trade mark of Lytag Ltd.

Table 2: Density Classes, design densities and modification factors based on BS EN 1992-1-1.

Property	Density Class	
	1.6	**1.8**
Density (kg/m^3)	1400–1600	1600–1800
Plain concrete (kg/m^3)	1650	1850
Reinforced concrete (kg/m^3)	1750	1950
η_1	0.84	0.89
η_E	0.53	0.67

Shear resistance

The design of members in shear that do not require shear reinforcement should be in accordance with Section 11.6.1 of BS EN 1992-1-1. Table 3 gives the shear stress for a reinforced (i.e. not prestressed) member without shear reinforcement using LC30/33 Lytag® LWAC with natural fine aggregate, based on:

$$v_{lRd,c} = (0.15/\gamma_c)\eta_1 k(100\rho f_{lck})^{1/3} \geq \eta_1 v_{l,min} \qquad \text{Equation 11.6.2}$$

where

k = $1 + \sqrt{(200/d)}$
ρ = $A_s/b_w d$
$v_{l,min}$ = $0.028k^{3/2}f_{lck}^{1/2}$ as given in Table 11.6.1N of BS EN 1992-1-1.

Lytag Ltd. 4 Bramley's Barn, The Menagerie, Escrick, North Yorkshire, YO19 6ET
Company registration number 6005140
Lytag® is a registered trade mark of Lytag Ltd.

Table 3: Values of design shear stress ($v_{lRd,c}$) for LC30/33 Lytag® LWAC with natural fine aggregate.

$100A_s/bd$	Effective depth (mm)			
	200	**250**	**300**	**400**
0.15	0.38*	0.36*	0.34*	0.30*
0.25	0.38*	0.36*	0.34*	0.30*
0.5	0.44	0.41	0.40	0.38
0.75	0.50	0.47	0.45	0.43
1.00	0.55	0.53	0.50	0.47
1.50	0.63	0.60	0.57	0.54
2.00	0.69	0.66	0.63	0.59

Notes: * Governed by $\eta_1 v_{l,min}$

The values in table 3 assume η_1 = 0.89, i.e. Density Class 1.8. For Density Class 1.6 they should be multiplied by 0.84/0.89
For other concrete grades the figures should be adjusted as follows:

- LC20/22 multiply by 0.87
- LC25/28 multiply by 0.94
- LC35/38 multiply by 1.05
- LC40/44 multiply by 1.10
- LC45/50 multiply by 1.14

The reduction in the permissible stress will be partly offset in structures carrying low live loads by the reduced self-weight stresses.
The design approach for Lytag® LWAC members requiring shear reinforcement is the same as for normal weight concrete (Section 6.2.3 of BS EN 1992-1-1) except that the maximum shear stress is limited to 5/6 that of the same grade of normal weight concrete (i.e. the same cylinder strength).

Punching shear of slabs

The punching shear resistance of Lytag® LWAC slabs is calculated as for normal weight concrete slabs in accordance with Section 6.4 of BS EN 1992-1-1. The shear stress for Lytag® LWAC slabs without shear reinforcement is the same as for Lytag® LWAC beams, see Table 3 above. Again the maximum shear stress is limited to 5/6 that of the same grade of normal weight concrete.

Lytag Ltd. 4 Bramley's Barn, The Menagerie, Escrick, North Yorkshire, YO19 6ET
Company registration number 6005140
Lytag® is a registered trade mark of Lytag Ltd.

Torsion in beams

The torsional resistance of Lytag® LWAC beams is calculated as for normal weight concrete beams in accordance with Section 6.3 of BS EN 1992-1-1. As with shear, the maximum torsional stress should be limited to 5/6 that of the same grade of normal weight concrete.

Detailing

Maximum bar size
BS EN 1992-1-1 suggests that the diameter of bars in lightweight concrete should not exceed 32mm and that not more than two bars should be bundled together.

Bend diameters
BS EN 1992-1-1 suggests that the diameter of bends for reinforcement in lightweight concrete should be 50% greater than for normal weight concrete to avoid the risk of splitting.

Bond and anchorage
In line with Section 8.4 of BS EN 1992-1-1, the ultimate bond stress is a function of the position of the bar during concreting and the size of the bar. For lightweight concrete, the ultimate bond stress should be reduced by the factor η_1 (see Table 2). Thus, bond lengths should be increased by 12% when using Density Class 1.8 Lytag® LWAC and by 19% when using Density Class 1.6 Lytag® LWAC.

Fire resistance

The assessment of fire performance is covered by BS EN 1992-1-2, Eurocode 2: Design of concrete structures – General rules – Structural fire design. Although the Scope states that “The methods … are applicable to … lightweight concrete up to strength class LC55/60”, material properties for lightweight aggregate concrete are not included. However, material properties for lightweight concrete are given in BS EN 1994-1-2, Eurocode 4: Design of composite steel and concrete structures – General rules – Structural fire design. Hence it should be possible to use the simplified calculation method (Section 4.3 in BS EN 1992-1-2) and the advanced calculation method (Section 4.4 in BS EN 1992-1-2) using these properties.

Lytag Ltd. 4 Bramley’s Barn, The Menagerie, Escrick, North Yorkshire, YO19 6ET
Company registration number 6005140
Lytag® is a registered trade mark of Lytag Ltd.

However, in many cases it will be sufficient to use Section 5 of BS EN 1992-1-2, which presents tabulated design data for normal weight concrete with siliceous aggregates, giving minimum dimensions and axis distances (distance from the axis of the reinforcing steel to the nearest exposed surface) for various types of member and various exposure periods. BS EN 1992-1-2 states that the minimum dimensions of beams and slabs may be reduced by 10% when lightweight aggregates (or calcareous aggregates) are used. In fact BS EN 1994-1-2 shows that the performance of lightweight aggregate concrete in fire is better than that of calcareous aggregate concrete, i.e. the reduction in strength with increasing temperature is somewhat less. Thus the assumption of a 10% reduction is probably conservative.
BS EN 1992-1-2 makes no mention of changing the minimum axis distance when using lightweight aggregate so one must assume that it is not affected. Also, one must assume that the minimum dimensions and axis distances for columns are not affected by the choice of aggregate.
Due to its relatively low thermal coefficient of expansion, Lytag® LWAC rarely spalls. The exception seems to be if the nominal cover exceeds 50mm.

Durability and cover to reinforcement

The durability requirements in BS 8500-1, Concrete – complementary British Standard to BS EN 206-1, do not differentiate between lightweight aggregate concrete and normal weight concrete. Thus for a given exposure condition, the same minimum compressive strength class based on cylinders (e.g. C40/50 and LC40/44) and associated maximum water/cement ratio and minimum cement or combination content will apply.
Section 11.4.2 of BS EN 1992-1-1 requires that the minimum cover to the reinforcement, which is required to ensure adequate compaction of the concrete and that bond forces between the reinforcement and the concrete can be safely transmitted, be increased by 5mm for lightweight concrete, as follows:

- Individual bars: bar diameter + 5mm
- Bundled bars: equivalent diameter + 5mm.

In all cases, the minimum cover should be increased by Δc_{dev} to give the nominal cover. This allows for the tolerance in fixing; Δc_{dev} is generally taken as10mm.

Lytag Ltd. 4 Bramley's Barn, The Menagerie, Escrick, North Yorkshire, YO19 6ET
Company registration number 6005140
Lytag® is a registered trade mark of Lytag Ltd.

Modulus of elasticity

The modulus of elasticity increases with the characteristic strength of the concrete. It is also affected by the aggregate/cement ratio and by the age of the concrete. For most purposes, an approximate estimate of the modulus is quite sufficient. For more precise values, tests on the concrete will need to be conducted.
The values of the elastic modulus for Lytag® LWAC given in Table 4 have been computed on the basis of the Eurocode 2 recommendations, which assume that the modulus of elasticity of lightweight concrete may be obtained by multiplying the modulus of the same grade of normal weight concrete by $\eta_E = (\rho/2200)^2$, where the values of η_E for Lytag® concrete are given in given Table 2.

Table 4: Modulus of elasticity.

Density Class	Lytag® LWAC grade					
	LC20/22	LC25/28	LC30/33	LC35/38	LC40/44	LC45/50
1.6	16	16	17	18	19	19
1.8	20	21	22	23	23	24

Elastic deflection

Since the modulus of elasticity of Lytag® LWAC is lower than that of normal weight concrete, greater initial elastic deflections might be experienced. However, these are off-set by the lower characteristic dead load of the Lytag® LWAC.
The basic span/effective depth ratios for Lytag® LWAC members are given in Table 5, which have been obtained by multiplying the ratios for normal weight concrete by the factor $\eta_E^{0.15}$, where the values of η_E for Lytag® concrete are given in given Table 2.

Lytag Ltd. 4 Bramley's Barn, The Menagerie, Escrick, North Yorkshire, YO19 6ET
Company registration number 6005140
Lytag® is a registered trade mark of Lytag Ltd.

Table 5: Basic span/depth ratios for Lytag® LWAC members.

Structural system	Concrete highly stressed ρ = 1.5%		Concrete lightly stressed ρ = 0.5%	
	Density Class 1.6	Density Class 1.8	Density Class 1.6	Density Class 1.8
Simply supported beam, one- or two-way spanning simply supported slab	13	13	18	19
End span of continuous beam or one-way continuous slab or two-way spanning slab continuous over one long side	16	17	24	24
Interior span of beam or one-way or two-way spanning slab	18	19	27	28
Slab supported on columns without beams (flat slab) (based on longer span)	15	17	22	23
Cantilever	5	6	7	8

The lower characteristic dead loads applicable with Lytag® LWAC generally reduce the required percentages of tension reinforcement steel in beams and slabs when compared with normal weight concrete construction.

Creep

The creep coefficient, used to determine the effects of long-term loading, depends on the concrete grade, the relative humidity of the environment and the member size (see Figure 3.1 of BS EN 1992-1-1). For lightweight concrete the creep coefficient determined from the Table is multiplied by $\eta_E = (\rho/2200)^2$. Thus for Lytag® LWAC, with natural fine aggregate, the factor is multiplied by 0.67 and for all-Lytag® LWAC it is multiplied by 0.53.

Lytag Ltd. 4 Bramley's Barn, The Menagerie, Escrick, North Yorkshire, YO19 6ET
Company registration number 6005140
Lytag® is a registered trade mark of Lytag Ltd.

Drying shrinkage

A practical value for the drying shrinkage of Lytag® LWAC is 0.035%. Alternatively, BS EN 1992-1-1 suggests that the drying shrinkage of lightweight concrete (for strength classes LC20/22 and above) may be taken as 20% greater than that for normal weight concrete, determined from Section 3.1.4.
Drying shrinkage occurs subsequent to water loss. The amount of shrinkage is dependent upon the composition of the concrete, the size of the section and the general environment. It is reduced by prolonged curing. Shrinkage cracking is rare in Lytag® LWAC because the water absorbed into the Lytag® LWA pellet during batching is available to cure the concrete over a longer period of time than normal weight concrete.

Poisson's ratio

Poisson's ratio may be taken as 0.20, as for normal weight concrete.

Coefficient of thermal expansion

The coefficient of thermal expansion of Lytag® LWAC is lower than for normal weight concrete and for practical purposes can be taken as 7×10^{-6} /°C.. (BS EN 1992-1-1 suggests a figure of 8×10^{-6} /°C "where thermal expansion is of no great importance".)

Lytag Ltd. 4 Bramley's Barn, The Menagerie, Escrick, North Yorkshire, YO19 6ET
Company registration number 6005140
Lytag® is a registered trade mark of Lytag Ltd.

REFERENCES

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

BS EN 1992-1-1 Eurocode 2: Design of concrete structures. General rules and rules for buildings

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

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

BRE Digest 330 Alkali–silica reaction in concrete

CIBSE Environmental Design Guide A

NA to BS EN 1992-1-1 UK National Annex to Eurocode 2. Design of concrete structures. General rules and rules for buildings

BOND, AJ et al. How to design concrete structures using Eurocode 2, The Concrete Centre, Camberley, 2006.

NARAYANAN, RS and GOODCHILD, CH. Concise Eurocode 2, The Concrete Centre, Camberley, 2006.

BS 8110-1:1997 Structural use of concrete. Code of practice for design and construction

BS EN 1992-1-2 Eurocode 2. Design of concrete structures. General rules. Structural fire design

BS EN 1994-1-2 Eurocode 4. Design of composite steel and concrete structures. General rules. Structural fire design

Lytag Ltd. 4 Bramley's Barn, The Menagerie, Escrick, North Yorkshire, YO19 6ET
Company registration number 6005140
Lytag® is a registered trade mark of Lytag Ltd.