04

Concrete

From 500 kg/m³ to 2,000 kg/m³
From 1 N/mm² to 70 N/mm²

www.argex.be

Contents

Argex expanded clay aggregates: 100% environmentally friendly

- **Argex** is a light pellet of expanded clay produced in a rotary kiln at 1,100°C. Argex pellets are insulating, rotproof, hard-wearing and fire-proof. They consist of a red-brown microporous shell and black core with cellular structure.

- **Argex** supplies an extensive range of clay aggregates (see table) from the lightest to the toughest. Technical specifications for each pellet size are available on request. The choice of the right Argex aggregate depends on the requirements you make of the concrete to be used.

- **Argex aggregates** suffice with regard to the most stringent standards for lightweight aggregates. Quality is monitored by both internal and external laboratories. The whole production process as well as the R&D and sales departments are ISO 9001-2000 certified. In January 2004 the coordinated *"EN – 13055-1: Light aggregates – Part 1: Light aggregates for concrete and mortar"*, standard replaced the different national standards. In addition to the CE mark (0965-CPD-GT0525), Argex also disposes of the KOMO certificate (The Netherlands – BRL 9325).

Types of Argex	Official name	Loose bulk density (dry kg/m³)	Particle density (dry kg/m³)
Normal Round	AR 0/2 – 800	800	1310
	AR 2/4 – 580	580	1100
	AR 0/4 – 650	650	1130
	AR 4/10 – 430	430	750
	AR 8/16 - 340	340	600
Normal Crushed	AG 0/2 – 580	580	1020
	AG 1/5 – 390	390	770
	AG 0/4 – 500 (sand)	500	920
	AG 4/8 - 320	320	670
Structural Round	AR 4/10 – 550	550	970
	AR 4/8 - 650	650	1130
Structural Mix	AM 4/8 – 650	650	1130
	AM 4/8 - 750	750	1310
Normal Mix (Screedmix/Roofmix)	AM 0/4 – 530	530	950

"**Normal**" pellets: pellets resulting from the normal production process.
"**Structural**" pellets: pellets expanded less during the baking process, so with a greater compressive strength.
"**Mix**": a mixture of crushed and round pellets .
Other pellet sizes are available on request.

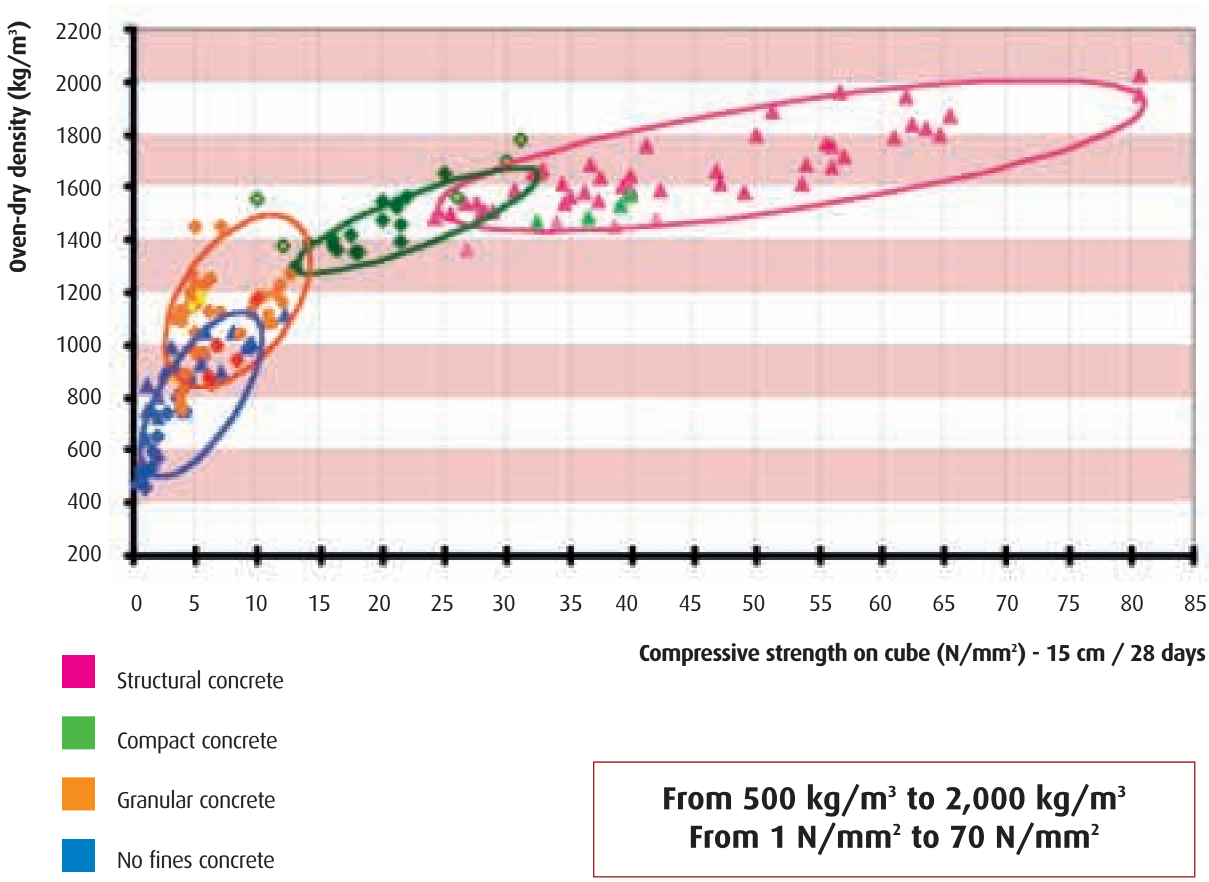
Lightweight concrete, a range of possibilities

Lightweight concrete can be defined as a concrete with an oven-dry density lower than 2,000 kg/m³, wholly or partly made up of light aggregates.

Because the Argex concrete mix designs are often created according to customer specifications, countless mixtures of different types of Argex are possible: round or crushed pellets, normal or structural, mixed with heavy sand or light Argex sand, water, different cement sorts and additives. Each building site does indeed have such specific requirements, and each prefab factory has different parameters.

The table below shows the different Argex concrete types with the relationship between concrete density and compressive strength.

Correlation between oven-dry density and compressive strength



From 500 kg/m³ to 2,000 kg/m³
From 1 N/mm² to 70 N/mm²

Note: The ratios included in this brochure are only an indication. By making changes you obtain concrete mix designs adapted specifically to your needs: e.g. using additives, different types of cement,...
The values specified for compressive strength were obtained in the laboratory after conducting tests on 150 x 150 x 150 mm cubes.

Advantages

- Low **weight by volume**
- Permanent thermal **insulation**
- Excellent **fire-resistance**
- **Easy to apply**
- Very good **compressive strength**
- **Low coefficient of thermal expansion**
- **Low modulus of elasticity**
- Excellent **sound absorption factor**
- Excellent **noise reduction coefficient** (despite low density)

argex

Argex-based concrete offers many advantages.

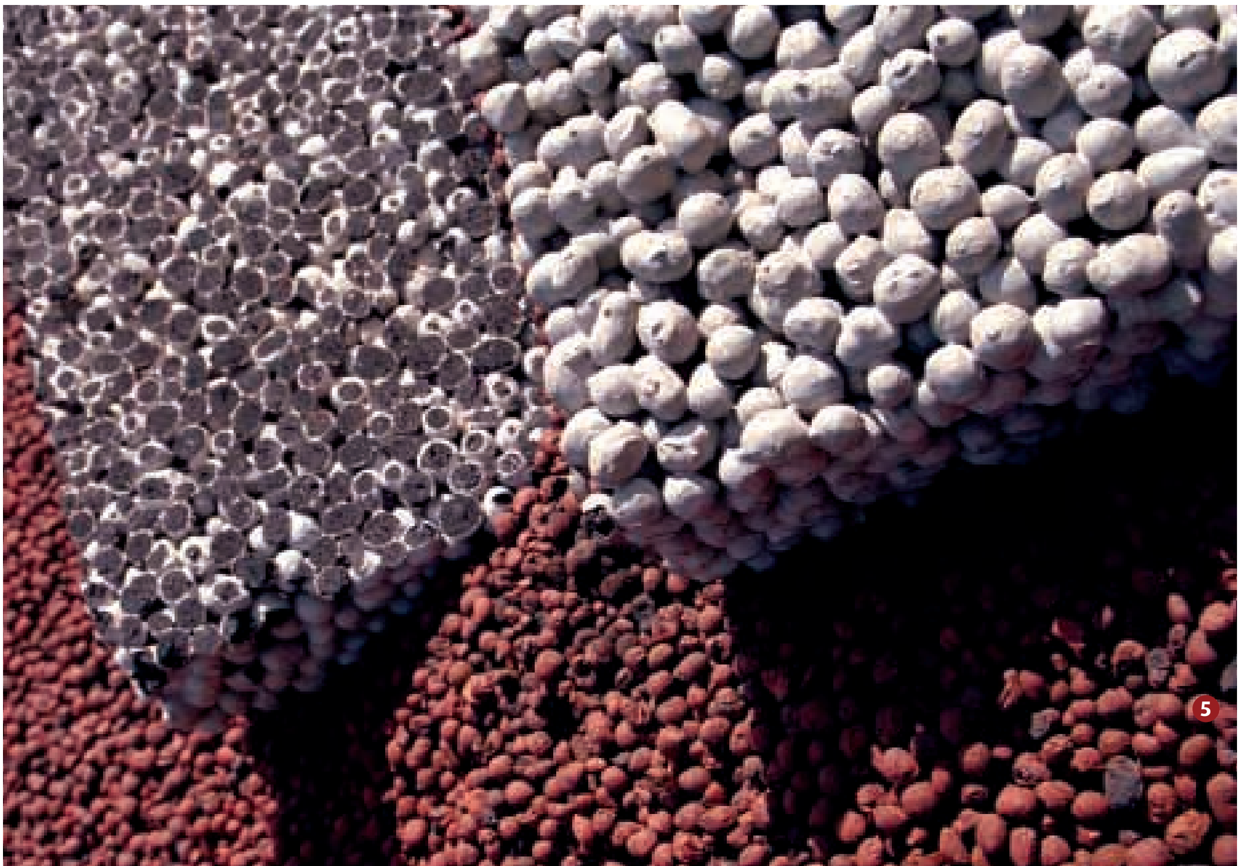
Argex no fines concrete

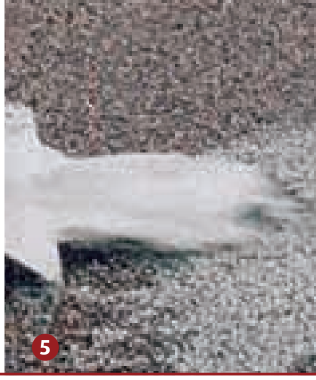
Advantages:
- Insulation
- Lightweight

Argex no fines concrete is a mixture of Argex aggregates and cement grout that encloses the pellets and adheres them to each other at their contact points. The concrete has a very open structure: there is 35 to 40 % hollow space between the pellets. The appearance and properties of the no fines concrete are related to the type of Argex pellet used.

Possible concrete mix designs:

1 m^3 Argex concrete	Argex AR 8/16-340	Argex AR 4/10-430	Argex Screed/Roofmix	Argex AR 0/4-650	Argex AR 0/4-650
Argex (litre)	1050	1050	1100	1100	1100
Cement (kg)	150	175	175	200	275
Dry density (kg/m^3)	520	650	800	950	1050
Compressive strength (N/mm^2 - 28d – cube 15 cm)	1	2	3-4	5-6	8
Heat conductivity (W/mK)	0.14	0.18	0.22	0.28	0.32
Concrete class EN 1520	D 0.6	D 0.7	D 0.8 LAC 2	D 1.0 LAC 4	D 1.2 LAC 6





Stabilising with cement grout

Argex filling and draining concrete

Applications

1. Argex no fines concrete owes its insulating properties and light weight to its low bulk density, without however this affecting its mechanical strength. This stony insulation material is incompressible, while also guaranteeing the same amount of enclosed air with long-lasting loading.

2. Argex no fines concrete is often used as a light and insulating screed or sloping screed. The low concrete density indeed limits the dead load on the building structures.

3. Roofmix/Screedmix was specially developed for screed pumps. These are mixtures of different fine Argex aggregates in certain proportions that enable them to be easily pumped.
Argex Roofmix/Screedmix has a fine surface texture and can consequently be perfectly levelled. Roofmix is easy to apply on gradients and no capping is needed. A roof covering and any additional insulation can be immediately applied to the sloping screed.

4. Other applications: light filling concrete and draining concrete.

5. Thicker fillings (>15 cm) are often supplemented by loose Argex, that are poured over afterwards with a high-grade cement grout (± 15 l/ m²; ratio 1kg cement/l water) in such a way that the upper layers of the aggregates attach to each other. This means the lightest fillings are obtained and there is no extra drying time.

Argex Roofmix

Argex insulating screed

Argex sloping screed with finishing layer

Argex granular concrete

Advantages:
- Insulation
- Lightweight
- Compressive Strength

By adding sand (light Argex sand or concrete sand) the hollow spaces between the pellets are partly filled. The weight by volume then increases, but adhesion is also strengthened so the compressive strength also increases. The concrete has a semi-open structure.

Possible concrete mix designs:

1m³ Argex concrete	Argex AG 4/8-320	Argex AR 4/10-430	Argex AR 4/10-430	Argex AR 4/10-430	Argex AR 4/10-430
Argex (litre)	600	1020	1000	950	1000
Argex sand (litre) AG 0/4-500	675	-	-	-	-
Concrete sand (kg)	-	250	400	500	400
Cement (kg)	175	150	175	200	175 + 100 filler
Dry density (kg/m³)	750	875	1050	1175	1200
Compressive strength (N/mm² - 28d - cube 15cm)	4	4	5-7	10	12
Heat conductivity (W/mK)	0.21	0.25	0.32	0.37	0.39
Concrete class EN 1520	D 0.8 LAC2	D 0.9 LAC2	D 1.2 LAC4	D 1.2 LAC8	D 1.2 LAC10

Applications

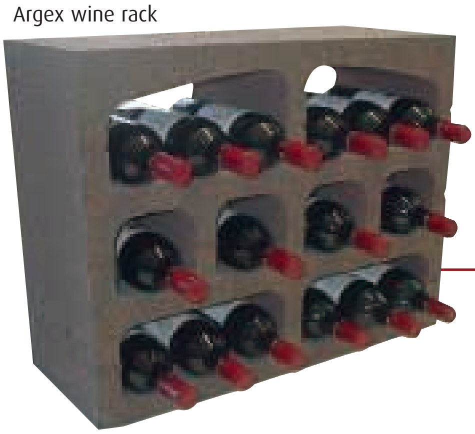
1. Argex blocks

Argex blocks often combine seemingly conflicting properties, such as lightweight, load bearing capacity, insulation, thermal and acoustic comfort. Argex blocks are manufactured in different sizes, concrete densities and compressive strengths according to the requirements in the country concerned.

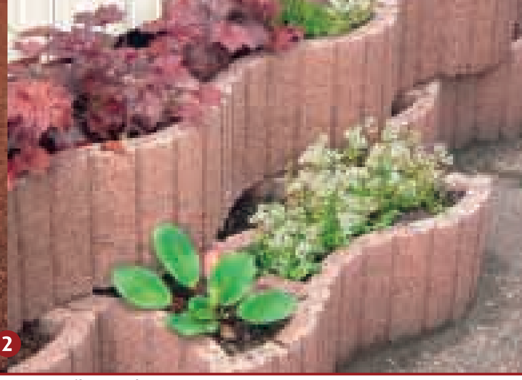
The reasons for using the blocks are the same everywhere however:
- **Excellent thermal insulation**
- **Excellent acoustic insulation**
- **High fire-resistance**
- **Easy to work with**
- **Lightweight**

Argex blocks are used in house building, public buildings and commercial buildings as supporting and non-supporting masonry, fire walls, acoustic walls, etc. Blocks with a fine texture or split or sawn blocks are used for fair-faced acoustic masonry.

Argex wine rack



Argex chimney element



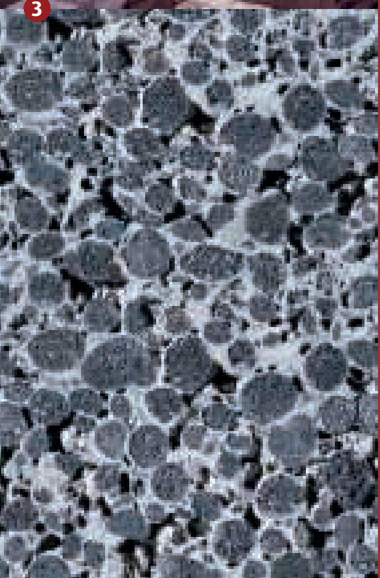
Argex flower boxes

2. Light prefab elements

A whole series of prefabricated concrete units are provided in Argex concrete. As a result they are lighter, easier to work with, and lorries can transport up to 50 % greater loads. Moreover, besides their light weight Argex gives these concrete units highly specific properties:

- Fire-resistance
- Decorative
- Moisture-regulating
- Frost-free

3. Argex beam and block system



A prefab floor is made up of beam and block systems in reinforced concrete, provided with a base and permanent formwork consisting of beam and block system in Argex concrete. They have a height varying between 13 and 20 cm.
To form the transverse ribs special blocks are supplied with a limited height of 8 cm. The monolithic character of the floor is ensured by the compressive layer applied.

As regards thermal and acoustic insulation, fire-resistance and weight, the Argex beam and block systems leave the competition standing. The thick-walled elements of tough Argex concrete can accommodate much greater point loads making them safer to use. The thick walls (3.5 cm) make it extremely easy to include cavities for spotlights or plugs for fitting wooden grating, for example. The rough texture of Argex concrete ensures the good adhesion of the plaster without prior treatment with primers being required.

Floor type	Height (cm)	Weight floor (kN/m²)	Infill concrete (L/m²)	Total Weight (kN/m²) / Max. Span (cm) support 2x10 cm			
				3.50	5.00	6.00	10.00
13 + 5 Single	18	2.60	67	480	-	-	-
20 + 5 Single	25	3.40	82	680	520	495	-
13 + 5 Double	18	2.90	81	-	480	455	-
20 + 5 Double	25	3.80	104	-	-	580	500

Contact our technical department for assistance with construction plans or the practical development of your site.

Argex compact lightweight concrete

Advantages:
- **Lightweight**
- **Compressive strength**

When all hollow spaces between the pellets are filled with sand we obtain compact Argex concrete. For this concrete type normal Argex pellets are used in combination with light Argex sand or ordinary concrete sand. The concrete density is greater compared to no fines concrete or granular concrete, but the compressive strength of the concrete obtained is considerably greater.

Possible concrete mix designs:

$1 m^3$ Argex concrete	Argex AR 4/10-430	Argex AR 4/10-430	Argex AG 4/8-320	Argex AR 4/10-430	Argex AR 2/4-580	Argex AR 0/4-650	Argex AR 4/10-430 + AG 4/8-320***	Argex AR 4/10-430	Argex AR 0/4-650	Argex AR 0/4-650
Argex (litre)	900	830	650	660	540	1000	825	500	900	650
Argex sand (litre) (AG 0/4-500)	-	-	570	-	-	-	-	-	-	220 *****
Concrete sand (kg)	600	650	550	800	815	150	700	930	450	600
Cement (kg)	300	350	350	400	400***	350	350	350+70 ****	380	400
Dry density (kg/m^3)	1375	1450	1300	1600	1650 - 1450*	1390	1570	1700	1570	1730
Compressive strength (N/mm^2-28d-cube 15cm)	14-16	15-20	15	20-25	20	30	25-28	30	37	40
Heat conductivity (W/mK)	0.46	0.51	0.43	0.60	-	0.47	0.58	0.67	0.58	0.70
Concrete class EN 206-1	D 1.4 - LC 8/9	D 1.6 - LC 12/13	D 1.4 - LC 12/13	D 1.6 - LC 16/18	D 1.6 - LC 16/18	D 1.4 - LC 20/22	D 1.6 - LC 20/22	D 1.8 - LC 20/22	D 1.6 - LC 30/33	D 1.8 - LC 35/38

(*) with air entrainer
(***) mixture of 50% AR 4/10 and 50% AG 4/8
(*****) addition of dense limestone aggregates
(**) often with white cement for decorative elements
(****) addition of filler

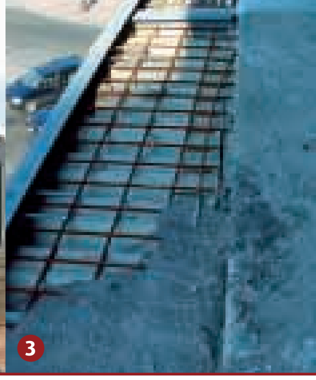
Applications

Light compact concrete is used as both Ready Mix concrete and for prefab applications. This is a lightweight concrete with a compressive strength reaching ± 30 N/mm^2 after 28 days. The following arguments are often of decisive importance with light concrete units: weight saving in constructions, optimum loading of lorries, the use of smaller hoisting appliances.
If it is necessary to obtain a greater compressive strength in a shorter period, structural Argex pellets must be used with which structural lightweight concrete is made (see the Structural lightweight concrete section).

1. Argex concrete panels

With a 1,450-1,700 kg/m^3 concrete density Argex compact concrete panels are up to 40% lighter than heavy concrete panels, this obviously giving advantages regarding transport and use. The panels are also fire resistant and have excellent insulating properties.

Masterblocks®



Compact concrete on dovetail sections (Tour Madou - Brussels)

Prefab cornices in lightweight concrete

2. Argex concrete units

Besides concrete panels an infinite range of concrete units can be made of Argex concrete: cornices, garden furniture, lintels, Masterblocks®,...

3. Ready Mix light compact concrete

For both tall buildings and renovation projects the use of lightweight concrete guarantees lighter loads on foundations on new and old structures.

4. Argex mortars

The use of light Argex aggregates gives the mortar two important properties: a light weight and fire-resistance.
The mortar owes its light weight to the fine Argex pellets (0/2 and 0/4 crushed) used, while allowing a light and insulating mortar to be made. The pellets also give their fire-resistant properties (see the Fire-resistance section) to the mortar, so it can withstand temperatures of 1,000°C to 1,100°C. The composition of the mortar can obviously be changed in line with its intended use. The mortars are mixed beforehand in bags or in silo, but can also be prepared for immediate use.

Argex concrete panels

Argex structural lightweight concrete

Advantages:
- Lightweight
- High compressive strength

Thanks to the development of "structural" Argex pellets the properties "lightweight concrete" and "high compressive strength" can be perfectly combined in one concrete, being Argex structural lightweight concrete. The structural Argex pellets are aggregates that are expanded less during the baking process, this resulting in improved mechanical properties for the concrete while also guaranteeing a low concrete density. These lightweight concretes with a density of between 1,500 and 2,000 kg/m³ reach compressive strengths of between 35 and 70 N/mm².

Possible concrete mix designs:

1m³ Argex concrete	AR 4/10-550	AM 4/8-650	AR 4/10-550	AM 4/8-650	AM 4/8-650	AM 4/8-650	AR 4/8-650	AM 4/8-650	AM 4/8-750	AM 4/8-750
Argex (litre)	730	750	550	800	740	490	730	800	880	750
Argex sand (litre) (AG 0/4-500)	-	-	-	-	0/4 G-320	0/4 R-650	-	-	-	-
Concrete sand (kg)	650	680	980	680	380	200	640	680	460	650
Cement (kg)	350-400	375	350	400	400	430	400	425	400	430
Dry density (kg/m³)	1510	1620	1730	1580	1550	1460	1620	1670	1620	1700
Compressive strength (N/mm²-28d-cube 15cm)	28	34	35	39	40	44	46	47	54	56
Concrete class EN 206-1	D 1.6 - LC 20/22	D 1.8 - LC 25/28	D 1.8 - LC 25/28	D 1.6 - LC 30/33	D 1.6 - LC 35/38	D 1.6 - LC 35/38	D 1.8 - LC 35/38	D 1.8 - LC 35/38	D 1.8 - LC 40/44	D 1.8 - LC 45/50

Applications

Pumpable Argex concrete (HST- Merksem)

1. Structural lightweight concrete in the prefab industry

Argex structural mix-aggregates (AM 4/8-650) are usually used for this purpose: this combination of round and crushed aggregates (± 25%) allows the easy application of the concrete, as well as good filling of the moulds and a better finish for the concrete surface.

2. Ready Mix structural concrete

Using lightweight concrete existing structures are put under less load and new structures (beams, engineering structures, etc.) can be provided in smaller sizes. The exact dimensions are calculated according to Eurocode 2 (see the Mechanical characteristics and Durability sections).

Structural Argex concrete can also be pumped (see Application of Argex concrete).

Archeoforum in structural lightweight concrete (Place St-Lambert - Liège)

3. Special concretes:

A. Self-compacting concrete (SCC)

Because self-compacting is already provided in ordinary concrete, a number of manuals with recommendations have already been drawn up. Argex adds its own rules based on the specific properties of Argex concrete. Interest is great: acoustic and thermal insulation, high mechanical strenght and a low density, etc.

Examples of concretes created:
LC 20/22 - D 1.6
LC 30/33 - D 1.6 to D 2.0

B. High strength concrete (HSC)

By optimising concrete mix designs (right aggregate choice, type of cement, use of fillers, optimisation of W/C factor, additives, etc.) it is possible to obtain a structural lightweight concrete with a high compressive strength.

Examples of concretes created:
LC 60/66 - D 1.8
LC 70/77 - D 2.0

Ceiling construction in light structural concrete (Place of pilgrimage - Beauraing)

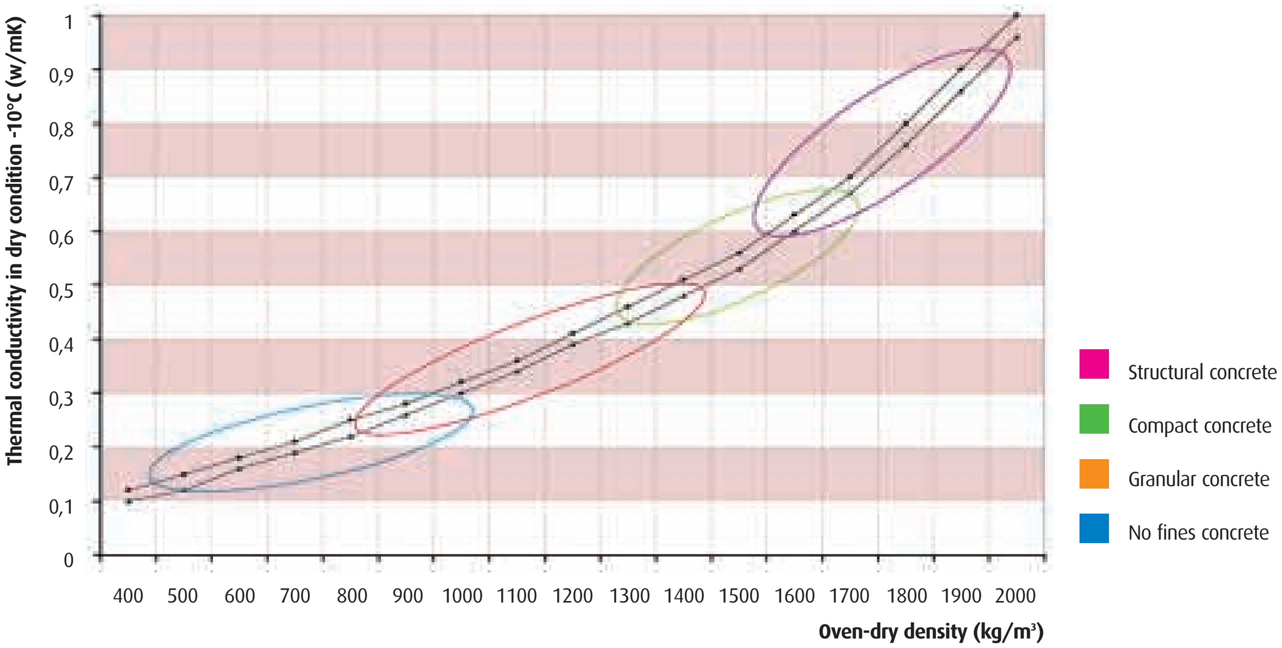
Prefab floor slabs in structural lightweight concrete

Properties of Argex concrete

1. Thermal insulation

The presence of light aggregates in concrete considerably lowers the **coefficient of heat conductivity***: it is thanks to the air enclosed in the cellular texture of the clay pellet that heat transfer is considerably restricted in comparison with heavy aggregates. Concrete with light aggregates is accordingly used worldwide to improve the thermal insulation of buildings.

*The coefficient of heat conductivity λ (W/mK) is usually expressed in relation to the dry density of the lightweight concrete. The heavier the concrete, the better the dissipation of heat, but the less the insulating capacity. The λ-values of lightweight concrete can be calculated on the basis of tables or based on measurements on concrete samples at a laboratory. Reference standards: EN1520, EN1745, EN12664, EN12667, EN12939.



2. Thermal inertia

Insulation impedes heat loss, but it is not the only factor that influences thermal comfort. Thermal comfort is indeed largely determined by the reaction of a wall to the changes to outside temperatures. Important criteria for this are:

- **the cushioning of the outside temperature cycle in relation to the inside temperature cycle**
- **phase displacement that ensures the inner climate responds more slowly to the varying outside temperature.**

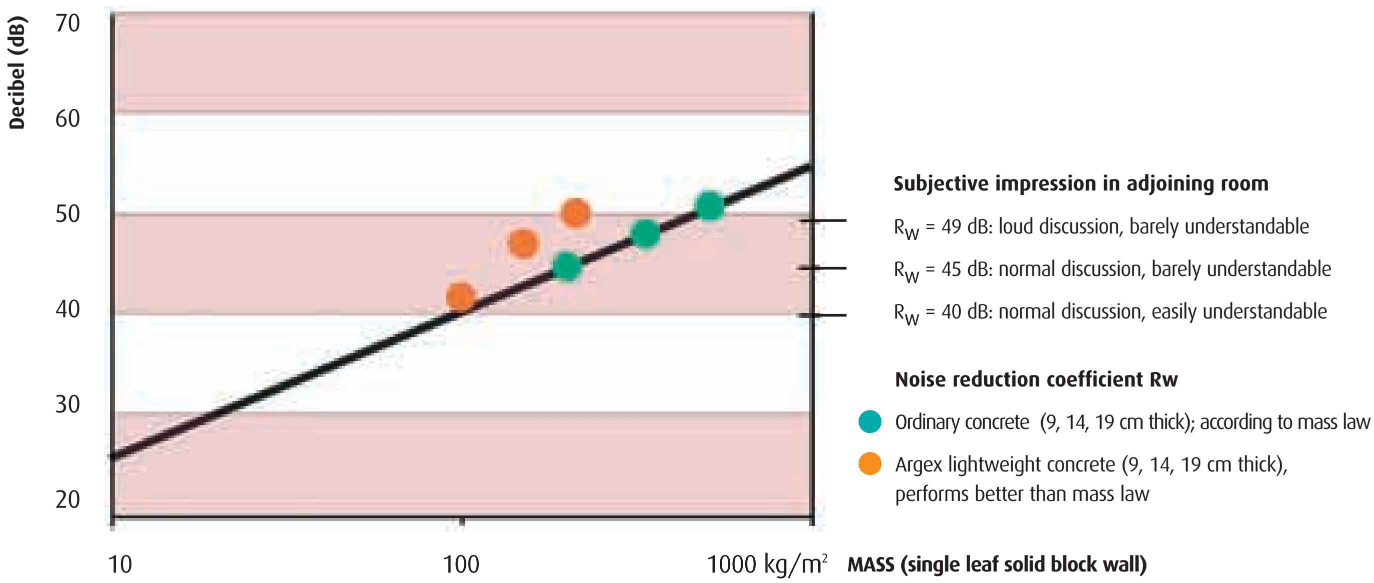
With a wall provided in Argex blocks the phase displacement is between 6 and 8 hours, and the cushioning of the outside temperature cycle in relation to the inside temperature cycle is factor 11. In real terms this means that the effect of an outside temperature fluctuation of 22 °C with an Argex wall would only be observed 7 hours later in the form of a temperature fluctuation of 2 °C.

3. Acoustic comfort

The acoustic comfort of a space is determined by:
- the acoustic properties of the space itself (sound absorption and reverberation time)
- protection against noise outside the space (noise insulation)

With its microporous texture Argex pellets are able to absorb a large amount of noise.
Once mixed with sand and cement, the pellets transfer these sound-insulating properties to the concrete.

Acoustic properties (insulation – airborne noise)



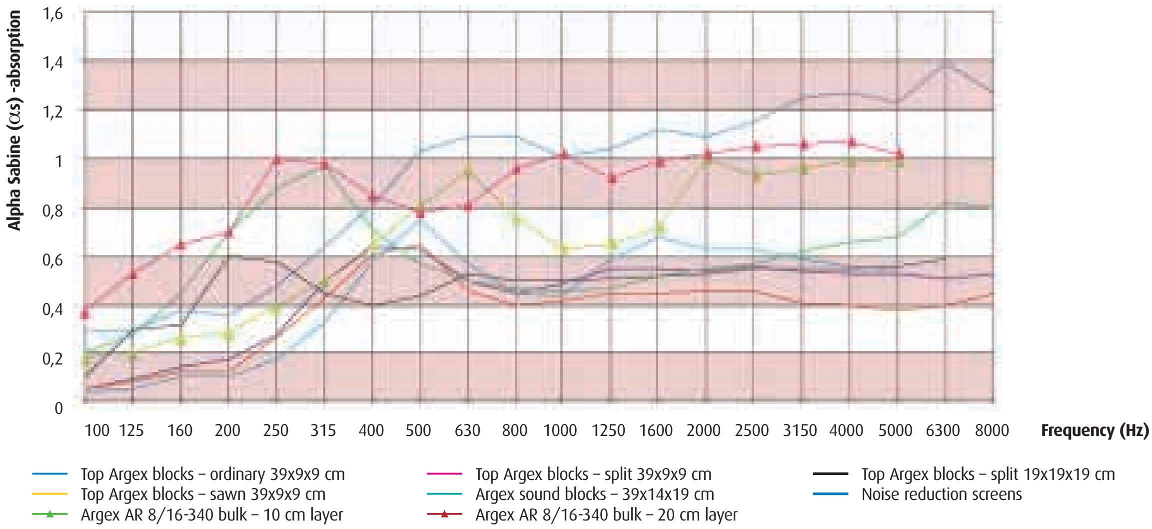
As regards **noise insulation** (noise reduction coefficient Rw expressed in dB), walls built of Argex concrete diverge from the "mass law": a wall in Argex concrete can be just as acoustically insulating as an equally thick wall in ordinary concrete, despite its lower density.

Noise reduction coefficient R Top Argex blocs (NBN 501 -500)*		
Thickness (mm)	Solid blocks 4/1.2	Hollow blocks 2/0.8
90	41 dB-IIIb	-
140	47 dB-IIIa	41 dB-IIIb
190	50 dB-IIb	45 dB-IIIa

* NBN 501-500: tests conducted on a wall consisting of Argex blocks and 1 cm of plastering on both sides of the wall.

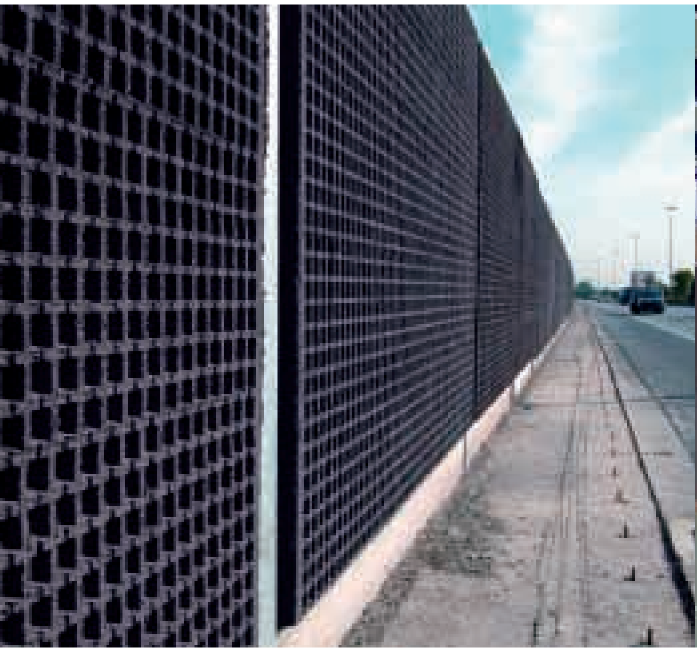
The sound absorption coefficient is a value for acoustic comfort in the transmitting space. The less absorption, the more reflection, the longer the reverberation time.
Absorption is always measured depending on the frequency of the sound waves, the porosity (40 % air in the pellet!) and the form of the surface, the density and thickness of the wall. This explains why equivalent sound waves will not reflect or be absorbed in the same way by different materials. The table below shows that Argex concrete has excellent results.

Acoustic absorption of Argex concrete



The excellent NRC* values explain the use of Argex blocks for dividing walls in office buildings, theatres, schools, sports halls, etc.

* NRC = Noise Reduction Coefficient



Noise reduction screen in Argex concrete along a motorway

Sports hall in fair-faced acoustic masonry:
combination of fine structural blocks and split blocks

4. Fire-resistance

The expanded clay pellets are baked at a temperature of ± 1,100 °C, so both the pellets and their derivative products, being the different Argex concrete sorts, achieve the Euroclass A1 or the “**fire-proof**” label.
Structural lightweight concrete has better fire-resistance than heavy concrete. These higher values are attributable to its **low thermal conductivity** (lower temperature increase in the concrete) and its **low coefficient of thermal expansion** (less stresses in the concrete). The **insulating property** of lightweight concrete gives better protection to the concrete reinforcement than heavy concrete, so concrete units of a smaller size can be used (between 5 and 20% less depending on the required concrete density).

Coefficient of expansion Argex pellets 4 to 8*10-6 1/°C
Coefficient of expansion Argex concrete: 6 to 9*10-6 1/°C
Coefficient of expansion heavy concrete: 9 to 12 * 10-6 1/°C

Rf classes (hours) NBN 713-020	Width of the building blocks (mm)	
	Solid blocks ρ 1.2 (kg/m³)	Hollow blocks ρ 0.8 (kg/m³)
Rf = 6	190	290
Rf = 3	140	290
Rf = 2	90*	190
Rf = 1	90	140

(*) only in the case of non-supporting walls

Argex concrete panel		
Rf = 4	d = 140 mm	ρ = 1600 - 1700 kg/m³

Rf Argex concrete panels: RF4 for panels with a thickness of 14 cm and a density of 1,600-1,700 kg/m³.

5. Refractory concrete

The non-combustible nature of the Argex pellets and Argex sand means both refractory mortars and refractory concrete units can be made. They are used for building industrial ovens, chimneys, etc. Concrete made with fire-proof cement, Argex pellets and Argex sand is resistant to temperatures to 1,100°C.


Argex BBQ element

Mechanical characteristics and durability:

1. Compressive Strength

The compressive strength of the Argex concrete is influenced by different parameters. It is known that open structure concretes react differently to these parameters than compact and structural concrete.

a. Influence of the type of Argex

The less the clay pellets expand, the heavier but also stronger they are, this obviously also having an influence on the strength of the no fines concrete made with them. Although the clay pellets have a lower compressive strength than traditional dense aggregates, their adhesion is much better than ordinary concrete because of the mortar paste. It makes the Argex concrete a “tough” concrete with a low modulus of elasticity. This partly compensates the lower compressive strength of the aggregates. Furthermore, with the pressure test the break will occur in the pellet itself or in the mortar paste and not along the pellet as is the case with ordinary concrete.

b. Influence of the concrete density

The correlation existing between the concrete density and the compressive strength with the four different kinds of Argex concrete is shown in the diagram on page 4. The compressive strength of the concrete normally increases with the density. Where the different concrete types overlap each other however, this rule can be departed from by making a lighter concrete with another pellet sort.

c. Influence of the cement quantity

Once the pellets are completely enclosed by the mortar paste, the influence of a higher cement quantity with open structure concretes is relatively limited. The compressive strength is indeed primarily determined by the pellets themselves: 10 kg more cement here means a higher compressive strength varying between 0.1 and 0.7 N/mm^2. The influence of the cement quantity is much greater with compact and structural concrete, where the mortar paste is the most important component:

an increase of 10 kg usually results in an increase of compressive strength of 0.2 to 3 N/mm^2.

d. Influence of the Water/Cement (W/C) factor, the use of additives and the resistance of "young" concrete

The rules concerning the W/C factor particularly apply to compact and structural Argex concrete. No account is taken here however **of the quantity of water absorbed by the pellets.** The use of additives is more the rule than the exception for lightweight concrete, and particularly for compact and structural concrete.
In this way the compressive strength can be increased with an equivalent consistency.

An example:
Structural concrete based on AR 4/8 – 650

E/C = 0.52	E/C = 0.38 with superplasticizer
• "fresh": 1,880 kg/m^3	• "fresh": 1,900 kg/m^3
• Flow: 1.83	• Flow: 1.3
• 24 h: 21 N/mm^2	• 24 h: 40 N/mm^2
• 28 d: 45 N/mm^2	• 28 d: 53 N/mm^2

Because the strength of the mortar fraction is greater than that of the pellet, the compressive strength of lightweight concrete will develop faster than in ordinary concrete. In general Argex concrete obtains much of its compressive strength in a relatively short time: after 7 days already 70% to 90% of the compressive strength obtained after 28 days!

e. Other parameters also exercise an influence on the compressive strength of Argex concrete, such as installations used, vibration frequency, hydration temperature, etc.

2. Other mechanical characteristics:

The mechanical characteristics can be either measured in the laboratory according to standardised methods, or calculated according to Eurocode 2 (*"Design of Concrete Structures – part 1: General rules"*) or EN 1520 (*"Prefabricated reinforced components of lightweight aggregate concrete with open structure"*). A separate section covers the dimensions of compact and structural lightweight concrete.

a. Tensile strenght

The tensile strenght is related to the density and the compressive strength of the concrete.
The tensile/compressive strenght ratio fluctuates on average between 5 and 15% for Argex concrete with a compressive strength >20 N/mm².

b. Modulus of elasticity

The modulus of elasticity (E-modulus) varies for Argex concrete between 2,000 and 25,000 N/mm², depending on the density and the compressive strength of the concrete. Its E-modulus amounts to 50 to 80% of a normal concrete with equal strength (calculation according to Eurocode 2 for compact and structural concrete, according to the EN 1520 standard for open structure concrete or according to measurements conducted at a laboratory).

Some examples:

Structural Argex concrete LC 35/38 – 1,690 kg/m³
E-modulus = 20,060 N/mm² (Eurocode 2)
20,270 N/mm² (Measured value WTCB - NBN B15-203)

Granular Argex concrete LAC 4 – 900 kg/m³
E-modulus = 4,018 N/mm² (EN 1520)
4,000 or 5,000 N/mm² (Measured value INISMA/GEOS)

c. Shrinkage

For granular concrete the following shrinkage and expansion values were noted:

Granular concrete	Shrinkage: 0.2 to 0.5 mm/m
(EN 1520)	Expansion: 0.06 to 0.5 mm/m (Measured value for Argex blocks – NBN B24 –208)

The shrinkage values of compact and structural concrete are calculated according to Eurocode 2. The measured values for Argex concrete are around 50 to 650 µm/m, depending on the density, compressive strength and W/C factor of the concrete. Lightweight concretes with the same compressive strength have different shrinkage values with different densities.

Examples of measured values (WTCB – NBN – B15 –216):

100 µm/m for 1,700 kg/m³ - LC 35/38
200 µm/m for 1,450 kg/m³ - LC 35/38 with light sand

From 40 N/mm² (for concrete class d = 1.8) the shrinkage of Argex concrete is comparable with that of an ordinary concrete.

The use of a small percentage of wet Argex pellets (a moisture level of 30 to 80% depending on pellet sort) in high strength concrete greatly reduces or even eliminates the autogenous shrinkage of the concrete. Because of its low W/C factor this concrete type is very sensitive to drying out with the curing process, so the compressive strenght, durability, etc. of the concrete can be affected. More information on request.

d. Creep

The creep values are calculated according to Eurocode 2 and EN 1520. It is the concrete density and compressive strength of the concrete that influence these values.

Examples of measured values (WTCB –NBN B15-228):

700 µm/m – 1,690 kg/m^3 - LC 35/38
1,300 µm/m – 1,450 kg/m^3 - LC 30/33 with light sand

From concrete class d = 1.8 the creep of the Argex concrete is comparable with that of an ordinary concrete.

e. Other parameters

Information and results about other parameters that influence lightweight concrete are available on request: shear strenght, adhesion of concrete reinforcement, water absorption, flexure, porosity, etc.

3. Durability

As regards permeability, for compact and structural lightweight concrete the same "rules of good workmanship" can be used as for ordinary concrete. The same "exposure classes" are also applicable (EN 206-1).

According to Eurocode 2, the concrete covering of reinforcement for compact and structural lightweight concrete must be increased by 5 mm compared to ordinary concrete. Otherwise the same rules are used as for ordinary concrete. In practice it appears that compact Argex concrete has just as good results as ordinary concrete as regards corrosion, carbonation and the impact of chlorides. Argex concrete also has better freeze-thaw resistance because of the porosity of the clay pellets.

Instructions for making Argex concrete

A series of recommendations concerning lightweight concrete are mentioned in EN 206-1 for the compact concrete sorts and in EN 1520 for light concretes with open structure. For concrete mix designs the tables in this brochure can be used as a basis. Obviously they can be adapted according to the specific information on the production unit.

The dosing of Argex pellets preferably takes place volumetrically, because the density of the pellets varies, including under the influence of humidity. If only weight dosing is possible, it is important with each delivery to express the quantity of required Argex in weight based on three representative samples taken from the available Argex.

When making the concrete the pellets breaking must be prevented. Breakage increases in the share of fine particles and therefore also the quantity of required mixing water, this affecting the quality of the concrete.
The mixing time is the same as for ordinary concrete.

Water and the W/C factor
The big difference between ordinary concrete and Argex concrete is the quantity of water present: because of the cellular nature the Argex pellets absorb a part of the water added. With the determining of the W/C ratio and the exposure class the same recommendations are applicable as for ordinary concrete. **The water absorbed by the pellets is NOT however counted with the establishment of the W/C factor.**

To prevent the Argex pellets fully absorbing the water needed for the hydration of the cement and the changing of the rheology of the concrete it is necessary to pre-moisten the (dry) Argex pellets. This involves the required quantity of “water n°1”, corresponding to the quantity of water absorbed by dry pellets after being fully submerged in water for 5 minutes.
How many “water n°1” are exactly needed obviously depends on the relative humidity of the pellets at the start. With a round pellet AR 4/10-430 this value varies between 60 and 80 litres of water per 1,000 l Argex, or pre-moistening for at least 30 seconds in a mixer. Very wet aggregates can be used without pre-moistening with “water n°1”. Argex has the tables needed to help you with the determining of the right quantity of “water 1”. Only after pre-moistening are sand, cement, mixing water (“water n°2”) and the additives added (in that order).
When determining the W/C factor and exposure class account only is taken of the mixing water or “water n°2”.

Moisture content equilibrium
Screeds, just like other concrete sorts, never dry out completely. They reach a moisture content equilibrium. The drying time depends on the ambient temperature, relative humidity, etc. (see diagram page 23). For Argex concretes this moisture content equilibrium lies, for example for filling screeds, between 6 and 8 % by weight, that which corresponds to ± 3% for ordinary concrete.

Examples:

Traditional screed:	1,900 kg/m^3	3 % = 57 l water/m^3
Argex Screedmix:	800 kg/m^3	7 % = 56 l water/m^3

Using Argex concrete

I. Application – compaction

To prevent the segregation and floating of the light Argex pellet sufficient attention must be devoted to the compaction of the concrete.
It is important to find a balance between the vibration time and the vibration frequency depending on the concrete mix design, the type of Argex pellet, the concrete consistency, etc. The same rules apply for Argex concrete as ordinary concrete.

2. Curing – protection

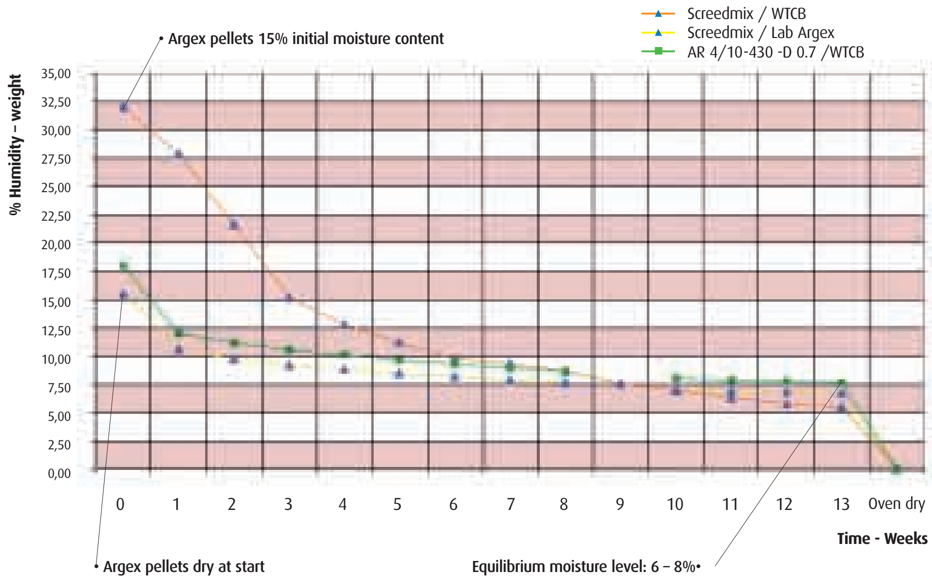
With the same cement quantity in an unchanged environment the Argex concrete reaches higher temperatures. With its mechanical properties, a low thermal coefficient of expansion and the hygrometric effect between the Argex pellets and the mortar the concrete can compensate for this warming up. It is therefore extremely important to follow the general rules for the drying out of Argex concrete (the same as for ordinary concrete). Because the strength of the cement paste is greater than the light aggregates, with lightweight concrete the compressive strength indeed develops much faster than with ordinary concrete.

3. Pumping Argex concrete

For the screeds (Argex Screedmix/Roofmix) and the filling concrete (no fines concrete and granular concrete) a traditional screed pump or a Turbo-Blower is recommended. Certain mix designs of structural Argex concrete can be pumped using a concrete mixer pump.
Different parameters must be matched first, such as:
- the Argex pellet and its moisture level
- the sand used
- cement and fillers
- concrete additives
- mixing water
- etc.

Argex has drawn up a number of guidelines for the good pumping of its lightweight concrete. You can request them from our Technical Department.

Argex Screedmix – Drying time curve/Equilibrium moisture level 20°C – 65% Relative humidity



Specifications

1. GENERAL

When using Argex concrete a distinction must always be made between concrete with a closed structure (as described in EN 206-1) and concrete with an open structure (EN 1520).

A. COMPACT AND STRUCTURAL LIGHTWEIGHT CONCRETE

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

This standard is applicable to Argex concrete with a closed structure: compact or structural concrete (LC = Light weight Concrete) with a concrete density between 800 and 2,000 kg/m³. Each light compact or structural concrete is specified as a combination of strength class and a density class. On the basis of this standard both the density and exposure classes can be determined.

Specification example: The lightweight concrete is created based on expanded clay aggregates (in conformity with EN 13055-1) and has the following properties: LC 35/38 - D 1.8

Strength class of lightweight concrete according to EN 206-1

Strength class	Minimum characteristic compressive strength on cylinder N/mm² (fck)	Minimum characteristic compressive strength on cube N/mm² (fck)
LC 8/9	8	9
LC 12/13	12	13
LC 16/18	16	18
LC 20/22	20	22
LC 25/28	25	28
LC 30/33	30	33
LC 35/38	35	38
LC 40/44	40	44
LC 45/50	45	50
LC 50/55	50	55
LC 55/60	55	60
LC 60/66	60	66
LC 70/77	70	77
LC 80/88	80	88

Density class of lightweight concrete according to EN 206-1 (dry density)

Density class	D 1.0	D 1.2	D 1.4	D 1.6	D 1.8	D 2.0
Density (Kg/m³)	≥ 800 and ≤ 1000	≥ 1000 and ≤ 1200	≥ 1200 and ≤ 1400	≥ 1400 and ≤ 1600	≥ 1600 and ≤ 1800	≥ 1800 and ≤ 2000

B. CONCRETE WITH OPEN STRUCTURE

EN 1520: Prefabricated reinforced components of lightweight aggregate concrete with open structure

This standard concerns Argex concrete with an open structure: no fines and granular concrete with a concrete density between 400 and 2,000 kg/m³. The concrete is described as Light Aggregate Concrete (LAC) and is used in the prefab industry for both structural and non-structural elements. Each light concrete with open structure is specified as a combination of a strength class and a density class.

Specification example: Lightweight concrete is made based on expanded clay aggregates (in conformity with EN 13055-1) and has the following properties: LAC 10 – D 1.2

Strength class of lightweight concrete according to EN 1520

Strength class	LAC 2	LAC 4	LAC 6	LAC 8	LAC 10	LAC 12	LAC 15	LAC 20	LAC 25
Characteristic compressive strength on cube (fck)	2	4	6	8	10	12	15	20	25

Density class of lightweight concrete according to EN 1520 (dry density)

Density class	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0
Average dry density (Kg/m³)	≥ 400 and ≤ 500	≥ 500 and ≤ 600	≥ 600 and ≤ 700	≥ 700 and ≤ 800	≥ 800 and ≤ 900	≥ 900 and ≤ 1000	≥ 1000 and ≤ 1200	≥ 1200 and ≤ 1400	≥ 1400 and ≤ 1600	≥ 1600 and ≤ 1800	≥ 1800 and ≤ 2000

2. INSULATING SLOPING SCREED

A. INSULATING LIGHTWEIGHT CONCRETE BASED ON EXPANDED CLAY AGGREGATES FOR FLAT OR SLIGHTLY INCLINED ROOFS WITHOUT FINISHING LAYER

MATERIALS

- Dry density (EN 992): 800 kg/m^3 (class D 0.9)
- Minimum compressive strenght: 30 kg/cm^2 or 3 N/mm^2 (classe LAC2) after 28 days (EN 1354)
- Coefficient of heat conductivity (EN 1520): 0.23 W/mK

Composition 1m^3 no fines concrete (without sand) "fine texture"

- Expanded clay aggregates AM 0/4 – 530 (Argex Screedmix) with a dry density of 530 kg/m^3 (in conformity with the EN 13055-1 standard): 1,000 l.
- Cement CEM III/A 42.5 or CEM I 42.5 R: 175 kg

IT IS NOT NECESSARY TO APPLY FINISHING LAYER TO THE ARGEX CONCRETE.

CARRYING OUT THE WORK

The lightweight concrete can be made either in an ordinary concrete mixer, by a screed pump or Turbo Blower, or using a concrete mixing plant. The pre-moistened expanded clay aggregates and the cement must be thoroughly mixed before water is added. The no fines concrete is poured on a clean and dry construction. The subfloor is provided according to the plan.

The minimum thickness amounts to 5 cm.
The gradient is provided according to the plan and amounts to at least 2 cm/m. Expansion joints in expanded polystyrene are provided every 30 m^2 of roof surface area.
After application the concrete must be protected for three days against rain and too fast drying out using polyethylene foil.
At low temperatures the general recommendations for winter work must be observed, as well as the manual for the concrete sloping screed and its application.

B. INSULATING LIGHTWEIGHT CONCRETE BASED ON EXPANDED CLAY AGGREGATES FOR FLAT OR SLIGHTLY INCLINED ROOFS WITH FINISHING LAYER

MATERIALS

- Dry density (EN 992): 520 kg/m^3 (class D 0.6)
- Minimum compressive strenght: 10 kg/cm^2 or 1 N/mm^2 (EN 1354)
- Coefficient of heat conductivity: maximum 0.14 W/mK (EN 1520)

Composition 1m^3 no fines concrete (without sand) "open texture":

- Expanded clay aggregates AR 8/16-340 (dry density 340 kg/m^3): 1,050 l.
- Cement CEM III/A or B 42.5: 150 kg (ratio 1:9)

CARRYING OUT THE WORK

The minimum thickness amounts to 5 cm.
The gradient is provided according to the plan and amounts to at least 2 cm/m. Expansion joints in expanded polystyrene are provided every 30 m^2 of roof surface area. 24 hours after pouring the concrete a finishing layer of at least 2 cm is applied.

Composition of the finishing layer:

- Sand: 1,000 l.
- Cement: CEM III/A or B 42.5: 300 kg (ratio 1:4).

The finishing layer is smoothed and levelled according to the drawing.
After application the concrete must be protected for three days against rain and too fast drying out using polyethylene foil.
At low temperatures the general recommendations for winter work must be observed.

3. INSULATING FILLING CONCRETE

A. INSULATING LIGHTWEIGHT CONCRETE FOR SCREEDS (FINE TEXTURE)

MATERIALS

- Dry density (EN 992): 800 kg/m³ (class D 0.9)
- Minimum compressive strenght: 30 kg/cm² or 3 N/mm² (class LAC2) after 28 days (EN 1354)
- Coefficient of heat conductivity (EN 1520): 0.23 W/mK

Composition 1m³ no fines concrete (without sand) "fine texture"
- Expanded clay aggregates AM 0/4 – 530 (Argex Screedmix) with a dry density of 530 kg/m³ (in conformity with the EN 13055-1 standard): 1,000 l.
- Cement CEM III/A 42.5 or CEM I 42.5 R: 175 kg

CARRYING OUT THE WORK

The lightweight concrete can be made either in an ordinary concrete mixer, by a screed pump or Turbo Blower, or using a concrete mixing plant.

The pre-moistened expanded clay aggregates and the cement must be thoroughly mixed before water is added. The no fines concrete is poured on a clean and dry construction. The subfloor is provided according to the plan.
Any piping present in the subfloor must be covered by a layer with a minimum thickness of 3 cm concrete and protected against corrosion. The necessary precautions must also be taken to protect the no fines concrete against mechanical damage.
The no fines concrete must be surface-moistened before the mortar finishing layer is applied.

B. INSULATING LIGHTWEIGHT CONCRETE FOR SCREEDS (OPEN TEXTURE)

MATERIALS

- Dry density (EN 992): 650 kg/m³ (class D 0.7)
- Minimum compressive strenght: 20 kg/cm² or 2 N/mm² (EN 1354)
- Coefficient of heat conductivity: 0.17 W/mK (EN 1520)

Composition 1m³ no fines concrete (without sand) "open texture"
- Expanded clay aggregates AR 4/10 (dry density of 430 kg/m³): 1,050 l.
- Cement CEM III/A or B 42.5: 150 kg

CARRYING OUT THE WORK

The no fines concrete can be made in an ordinary concrete mixer, using a screed pump or with a concrete mixing plant.

The pre-moistened expanded clay aggregates and the cement must be thoroughly mixed before water is added. The no fines concrete is poured on a clean and dry construction. The subfloor is provided according to the plan.

Any piping present in the subfloor must be covered by layer with a minimum thickness of 3 cm concrete and protected against corrosion. The necessary precautions must also be taken to protect the no fines concrete against mechanical damage.
In normal conditions after 24 hour all pellets will be well-bonded by the solidified cement grout or mortar.

CONCRETE STANDARDS

EN 206-1:2001	Concrete - Part 1: Specification, performance, production and conformity
EN 990:2002	Test methods for verification of corrosion protection of reinforcement in autoclaved aerated concrete and lightweight aggregate concrete with open structure
EN 991:1995	Determination of the dimensions of prefabricated reinforced components made of autoclaved aerated concrete or lightweight aggregate concrete with open structure
EN 992:1995	Determination of the dry density of lightweight aggregate concrete with open structure
EN 1352:1997	Determination of the static modulus of elasticity under compression of autoclaved aerated concrete or lightweight aggregate concrete with open structure
EN 1354:1997	Determination of compressive strength of lightweight aggregate concrete with open structure
EN 1355:1997	Determination of creep strains under compression of autoclaved aerated concrete or lightweight aggregate concrete with open structure
EN 1356:1997	Performance test of prefabricated reinforced components of autoclaved aerated concrete or lightweight aggregate concrete with open structure under transverse load
EN 1520:2003	Prefabricated reinforced components of lightweight aggregate concrete with open structure
EN 1521:1997	Determination of flexural strength of lightweight aggregate concrete with open structure
EN 1737:1998	Determination of shear strength of welded joints of reinforcement mats or cages for prefabricated components made of autoclaved aerated concrete or lightweight aggregate concrete with open structure
EN 1739:1998	Determination of shear strength for in-plane forces of joints between prefabricated components made of autoclaved aerated concrete or lightweight aggregate concrete with open structure
EN 1740:1998	Performance test for prefabricated reinforced components made of autoclaved aerated concrete or lightweight aggregate concrete with open structure under predominantly longitudinal load (vertical components)
EN 1741:1998	Determination of shear strength for out-of-plane forces of joints between prefabricated components made of autoclaved aerated concrete or lightweight aggregate concrete with open structure
EN 1742:1998	Determination of shear strength between different layers of multi-layer components made of autoclaved aerated concrete or lightweight aggregate concrete with open structure
EN 1745:2002	Masonry and masonry products - Methods for determining design thermal values
EN 12350-1 t.e.m. 7	Testing fresh concrete
EN 12390-1 t.e.m. 8	Testing hardened concrete
ASTM C 173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
EUROCODE 2	Design of Concrete Structures – part 1: General rules

Photographs page 6, 8, 10, 11 (bottom left): Thaïs Verhelst.
Photograph page 13 and graph page 15: Febelcem.

ARGEX BELGIUM

Kruibeeksesteenweg 227
B-2070 Zwijndrecht (Burcht)
tel. +32(0) 3 250 15 15
fax +32(0) 3 250 15 00
info@argex.be
www.argex.be

ARGEX THE NETHERLANDS

Doesburgweg 7, 0.1F
NL-2803 PL GOUDA
tel. +31(0) 182 69 82 25
fax +31(0) 182 69 87 50
info@argex.nl
www.argex.nl

ARGEX FRANCE - PARIS

16, Rue du Général Leclerc
F-95320 Saint-Leu La Fôret
tel. +33(0) 134 18 25 10
fax +33(0) 139 60 93 36
info@argex.fr
www.argex.fr

ARGEX LOCAL AGENT:

argex