CLC Cellular light weight concrete

Foam Concrete is also Known as "Cellular light weight concrete", "CLC", "Foamed cement", "Light Weight Concrete" across the world with its greater advantages from 5 years. The basic foam concrete is made from mixing aqueous foam which is produced from generators (IFG) into Slurry of Cement, fly ash OR sand, water and other additives in a precise mixing in foam concrete mixer(IFM) for accurate mixing without disturbing its original chemical and physical properties.

Advantages

- Light in Weight
- High Thermal Insulation
- High Fire Protection
- High Sound Insulation
- Lower Water Absorption
- Eco Friendly
- Economical

Applications

- Blocks
- Panels
- Ceiling Panels
- Pre-cast Exterior Walls
- Void Filling
- Roof Insulation
- Thermal Insulations
- Sound Insulation
- Floors
- Cast Insuit Applications
- Tank Infill
- Road Construction
- Subway Infill
- Tunnel Infill
- Mine Infill
- Water Proof Material
- Floors
- Low Cast Housing
Advantages in detail:

- **Savings in Raw Material:** The tremendous savings described when using CLC are manifold, continuing with substantial savings in raw material (no gravel required), in dead load of high-rise reducing by almost half. Considering that a substantial amount of steel is necessary only to carry the weight of the structure, steel requirement might reduce by hundreds of ton in high rise.

- **Considerably Lower Weight:** Weight reduction is obvious in transport, where almost double of volume of building material can be produced, it has an impact on craning, where either larger panels can be taken, or the full capacity in span. Alternatively less re-location of the crane is necessary.

- **Thermal Insulation:** Thermal Insulation increasingly turns to be the most important issue in the planning and construction of buildings. There are many costly ways of insulation on sandwich structure of a wall, adding the one or another rigid insulation material, with a satisfactory result by computation but not always a sound solution in safety, health or environment. The best solution is, to incorporate thermal insulation in the mix of a concrete, such offered in air-cured CLC.

- **Fire Protection:** The air-embedded in the CLC is also instrumental for the high fire-rating. In 1200 kg/m³ density a 13-14 cm thick wall has a fire endurance of 5 hours. The same delay occurs with a 400 kg/m³ layer of CLC in only 10 cm thickness. CLC is otherwise non-combustible.

- **Sound Insulation:** Over the efforts to keep on increasing the thermal capacity of building members, other aspects have been neglected, such as sound insulation. Sound is experienced as air-borne or foot-fall sound (impact). Air-borne it is a rule of density and therefore CLC offers superior protection than very light concrete (ACC). In impact sound it is superior to conventional concrete. Hitting a wall with a hammer, will let you feel the full force on the other side, whilst the air embedded in CLC will not allow the blow to pass through. At the most it will suffer a small dent and thereby prevent any greater damage.

- **Insulated Flooring:** As the impact force will not transmit, slabs produced of CLC or topped with a layer of CLC floor screen will prevent any sound being noticed in the room below. Walls of CLC will also serve as sound retaining walls on roads or railway tracks therefore, absorbing the sound and preventing it from bouncing to the other side.

- **Customisable Physical Properties:** Adding fibers to CLC is a further important benefit, increasing bending stress substantially and most of it impact strength. The three dimensional acting fiber (e.g. polypropylene) will further reduce shrinkage, therefore reducing water absorption and increasing strength (up to 25 %). This is appreciated most when producing slender building components.

- **Economical Production:** Using only flyash, cement, water and foam, the cost for one m³ of CLC in most cases is less even than for the equivalent volume of conventional concrete. Adding all the described highly appreciated benefits (comprising CLC) to regular concrete, if at all possible, the cost for such regular concrete would probably double but still not reach the overall quality of CLC.
Technical Specifications

Walls of CLC have excellent sound insulation

CLC Bricks are available in 3 grade strengths:

- Grade A: These are used as load bearing units & have a brick density in the range of 1,200 kg/Cum – 1,800 kg/Cum
- Grade B: These are used as non-Load bearing units & have a brick density in the range of 700 – 1,000 kg/Cum.
- Grade C: These are used for providing thermal insulation & have a brick density in the range of 400 – 600 kg/Cum.

Technical Specifications of CLC Bricks:

<table>
<thead>
<tr>
<th>Brick Size (mm)</th>
<th>Approximate Weight/Brick (Kg)</th>
<th>No. of Brick/Truck</th>
<th>No. of Bricks/Cu.Mtr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>600 x 200 x 200</td>
<td>20.500</td>
<td>305</td>
<td>41</td>
</tr>
<tr>
<td>600 x 200 x 150</td>
<td>15.500</td>
<td>416</td>
<td>55</td>
</tr>
<tr>
<td>600 x 200 x 100</td>
<td>10.250</td>
<td>610</td>
<td>83</td>
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Grade wise comparison of CLC Bricks:

<table>
<thead>
<tr>
<th>Type</th>
<th>Density</th>
<th>Min. Compressive Strength N/mm²</th>
<th>Water Absorption %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade A</td>
<td>1800</td>
<td>25.0</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>1600</td>
<td>17.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Type</td>
<td>Density Min. Compressive Strength N/mm²</td>
<td>Water Absorption %</td>
<td></td>
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<td>----------</td>
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<tr>
<td></td>
<td>1400</td>
<td>12.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1200</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>Grade B</td>
<td>1000</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>800</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Grade C</td>
<td>600</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>400</td>
<td>0.5</td>
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</tbody>
</table>

**Recommended usage of CLC based on density:**

- **Density 300-600 kg/m³**: This density is primarily applied for thermal insulation or fire protection. It uses only cement (or little flyash), water and foam and can easily be pumped. Foam generators allow the production of stiff foam for slopes to be applied on roof-tops.

- **Density 700-800 kg/m³**: Is also used for void-filling, such as an landscaping (above underground construction), to fill voids behind archways and refurbishing of damaged sewerage systems. It is also been used to produce building blocks.

- **Density 900-1100 kg/m³**: Serves to foremostly produce blocks and other non-load bearing building elements such as balcony railings, partitions, parapets and fence walls etc.

- **Density 1200-1400 kg/m³**: Are the most commonly densities for prefab and cast in situ walls, load-bearing and non-load-bearing. It is also successfully used for floorscreeds (sound and insulation plus weight reduction).

- **Density 1600-1800 kg/m³**: would be recommended for slabs and other load-bearing building elements where higher strength is obligatory.

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**Compare CLC**

<table>
<thead>
<tr>
<th>S.</th>
<th>Parameters</th>
<th>Cellular Lightweight Concrete Bricks</th>
<th>Burnt Clay Bricks</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>Description</td>
<td>Material/Property</td>
<td>Details</td>
</tr>
<tr>
<td>-----</td>
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<td>--------------------------------------------------------</td>
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</tr>
<tr>
<td>2.</td>
<td>General Properties</td>
<td>Dry Density kg/m$^3$</td>
<td>750 – 800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Compressive Strength in kg/cm$^3$</td>
<td>25 – 30</td>
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<tr>
<td></td>
<td></td>
<td>Range of applications / utility</td>
<td>Partition</td>
</tr>
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<td></td>
<td></td>
<td>Aging</td>
<td>Gains strength with age</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thermal Conductivity (W/m.k.)</td>
<td>0.132-0.151 for 800 kg/m$^3$</td>
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<tr>
<td></td>
<td></td>
<td>Sound Insulation</td>
<td>Superior than burnt clay &amp; hollow concrete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ease of Working</td>
<td>Can be cut, nailed &amp; drilled</td>
</tr>
<tr>
<td>3.</td>
<td>Shape &amp; Form</td>
<td>Pre-cast Brick size</td>
<td>600 x 200 x 100/150/200 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pre-cast elements</td>
<td>Any size of elements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cast in shape</td>
<td>Any shape &amp; size in any density</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td>Water Absorption % by weight</td>
<td>12% for 800 kg/m$^3$ density (by volume)</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>Drying Shrinkage mm/meter</td>
<td>0.10</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>Productivity</td>
<td>Output 100% more than brick work</td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td>Eco Friendliness</td>
<td>Pollution freeLeast energy requiement Can</td>
</tr>
<tr>
<td>8.</td>
<td>Structural saving due to dead weight reduction</td>
<td>55% reduction in weight of walls. Tremendous structural saving for high rise buildings in Earthquake / Poor soil area</td>
<td>No additional saving</td>
</tr>
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**CLC Manufacturing**

CLC manufacturing setup is cheap & profitable and highly customisable.

**Required Equipment**

- MFG / MFG-A Foam Generator
- Conventional Mixers, pan-mixer, truck-mixer
- Conventional conveying system (buckets, Concrete pumps etc)
- Conventional moulds, horizontal/vertical

**Raw Material**

- flyash or sand (2, 4, 6, 8 mm, depending on density and availability)

**Preference**

- Flyash
- min. 20% fines
- Cement, Preference Portland
- Water for Foam production: Potable
- Foaming Agent

**Optional**
• Fibre: Polypropylene
• Fly-ash up to 40% on total mix
• Lightweight Aggregate (e.g. expanded clay etc.)

**Production Procedure**

**Flyash:** Optimum properties are achieved when selecting the most suitable raw material (flyash, Cement). Preference: power-plant flyash, sieved and with minimum 20% fines. Impurities in flyash increases the demand for water and cement, without adding to the properties. It also increases shrinkage. A certain, small amount (20%) of fines contributes towards strength. As in conventional concrete (CC), the flyash should be free of organic material or other impurities. Crushed sand, due to sharp edges may destroy the foam mechanically hence not recommended.

**Cement:** Portland cement is preferred over other cements, such as pozzolan. For Early stripping and optimum mechanical properties, high-grade (early strength) cement is recommended. Thick walls and when using battery-moulds, excess heat is developing within and might therefore ask for a lesser grade of cement. Remember: The slower the hardening, the better the final quality of concrete. Where economical, fly-ash may be added to the mix to substitute some of the cement. Fly-ash normally will retard hardening though.

**Water:** When used to produce foam, has to be potable and for best performance should not exceed 25°C. Under no circumstances must the foaming agent be brought in contact with any oil, fat, chemical or other material that might harm its function (Oil has an influence on the surface-tension of water). The oil/wax used in moulds will not harm, since the foam by then will be embedded in mortar. Water to prepare the mix has to conform with general requirements for concrete.

**Foaming Agent:** The containers holding foaming agent must be kept air-tight and under temperatures not exceeding 25°C. This way the shelf-life is guaranteed for 24 months from date of Invoice. Once diluted in 40 parts of potable water, the emulsion must be used as soon as possible.

**Correct density of foam:** The weight of the foam should be minimum 80 g/l. Use a containers of as close as possible to 10 liters in volume, to check the weight (density) of the foam. Smaller containers may not allow to pour foam into, without possible large voids. A fast check on the correct weight is also possible by turning the bucket with foam up-side down. If the weight of the foam is minimum 80 g/l and does not drop out of the bucket, the consistency of the foam is correct. After several weeks of experience the person in charge of producing foam will know the correct quality of the foam by sight. Once set correctly, the foam generator will keep the consistency stable, as long as air-and water-supply remains constant as well. We still recommend to check the weight of the foam once in a week or if the density/consistency of the mix varies.

**Preparation of moulds:** For smooth surfaces clean moulds completely of remaining concrete, the steel/or wood surface must be oiled/waxed. Preference: Organic or vegetable oil/wax. Trials with different materials will have to show best results. Oil or wax will not destroy the mix, once the foam has been mixed in the mortar.
Steel reinforcement will be placed in the moulds as usual. No coating of the steel is necessary – as in AAC (Syporex etc.) In panels of more than 12-15 cm thickness, we recommend the use of a double mesh (100 x 100 or 150 x 150 mm). The steel connected to the lifting anchors should reach more than half of the width of the panel and should possibly not be connected to the mesh. Ordinary steel is used as in CC when casting densities of 1200 or higher. The high ratio of cement to material in CLC ensures proper protection of the steel against corrosion.

The steel embedded has to be covered by minimum 25 mm of concrete. The use of spacers is recommended. To prevent cracking when lifting/tilting, steel rods may be placed across the anchors. A triangular strip of plastic or wood might be inserted along the bottom edge of the mould – better also along the top, to prevent sharp edges, that might break off when handling and give the panels a poor appearance.

**Charging, Mixing and Pouring:** Before charging the mixer with material, it must be rinsed, in particular if the concrete produced before, used any additive, which might have adverse reaction on the foam. Where possible, start the mixer before charging it with material. If the flyash contains excessive amount of water, the weight has to be adjusted, adding that much more flyash as it contains water by weight, reducing at the same time the amount of water to be added to the mix. To obtain optimum performance, flyash is first fed into the mixer, first absorbing water left after rinsing or from the previous (CLC-) mix.

This way, the cement to follow will not clod, allowing best possible distribution in the flyash. Keep on mixing, until a homogenous colour of the mix is achieved. If using fibre, this is the moment it has to be added, mixing approx. 1 min. for each kg added, to allow the fibrillated polypropylene fibre to “open-up”.

Check “Recommended Mix Design” for the recommended configuration of material to be used in different densities. The densities referred there-under are oven dry, achieved when drying the mix for 24h at 105°C. Before adding foam, the water/cement (w/c) ratio of the mortar must be minimum 0.35. Lower ratios may cause the cement to draw water from the foam, causing it to partly or totally collapse, increasing the density and decreasing the yield. This is one of the most likely mistakes when learning how to produce CLC. Therefore, if one is in doubt, one should always add more, rather than less water. To a certain extend this might even increase initial strength. Doing the same with CC would definitely reduce strength, as excessive water causes voids when evaporating. CLC on the other hand consists of voids only. The weight of the foam should be minimum 80 g/l. Use a container of as close as possible to 10 liters in volume, to check the weight (density) regularly.

Gravity mixers (e.g. Ready Mix) take the foam under almost instantly and distribute it homogeneously in the mix. It takes more time to achieve a proper distribution when using pan-mixers or similar. In between pours, the mixer should be kept in motion until it is completely discharged.

CLC always should be poured in the shortest possible time. If buckets are used to fill moulds, they should hold as much CLC as possible, possibly even pouring one complete panel in one
step. Extended time between pours of one building member might result in the creation of dry-joints as happening in the case with regular concrete as well.

Although CLC does not require vibration – at least not to densify the mix – which is liquid anyhow, vibration of horizontally produced panels will show an even better surface, drawing cement slurry to the mould side. Preference is given to High-Frequency vibrators. Length of vibration 15-20 sec. or until bubbles on the surface appear in large numbers. Use aluminium or other straight and sharp-edged screeds immediately after pouring the concrete. Delayed screeding might “smear” the surface. If moulds have to be moved after screeding, this might have to be repeated. Any disturbance of the freshly poured CLC during the setting process, might be harmful and cause part of it to collapse, in particular when the concrete is not hard enough yet to carry the weight and the foam has been weakened by loss of water, drawn by the cement already for setting.

The poured building member should be covered, if possible, with a canvass or plastic sheet to keep the evaporating water on the surface. As with CC, hardening may be accelerated either by heating the moulds, steam or chemical (ask for details). Using most standard types of cement, panels may be lifted the day after casting. Due to the reduced strength in CLC, moulds should be tilted before lifting the panels. For the same reason panels of CLC should be handled with utmost care to avoid damage.

**Curing / Transport / Assembly:** Panels should be positioned upwards on the curing yard, resting on a soft underground – best on a rake or wooden beams. All possible efforts should be taken, in particular in dry and hot climate or more even when windy, to keep the panels damp for at least three, better for more days. A sprinkler will be helpful or canvas that is kept wet. Curing compound would be the costly alternative. Standards call for a 24 day curing period for cement-based building members.

*Remember: Cement/Concrete only hardens with water or in a humid environment.*

Due to reduced weight, more volume of CLC building elements can be transported at the same (increased pay-load) then of CC. Panels should be kept upright during transport and also on a soft/wooden underground. Unload only in tilted position.

**Assembly:** Assembly of panels in CLC happens usually the same way as with CC. Special care has to be taken not to apply any mechanical force to avoid damage. If necessary, panels of CLC may be sawn (no gravel), definitely nailed (without the use of dowels as in AAC), drilled or profiled. In densities of 1200 kg/m³ and higher, where reinforcement is used, CLC requires no special coating/plaster on the outside. Water-repellent paint (dispersion-paint) will be suitable.

**Vertical casting:** The high fluidity of CLC allows full height walls or complete houses (floor by floor) to be cast in one pour, inclusive the slab. Frames for voids for windows, doors and other opening, or penings therefore are cast in place, together with empty tubes and pipes for power and sanitary. No voids, no sagging (beneath frames). Walls/ partitions may be as slender as 50 mm thick only as no vibration is necessary. With a coarse sand-paper stuck to a piece of board, rub the walls immediately after stripping, in circular motion, to eliminate possibly honey-web or
“noses” caused by possible irregularities in the mould or by joints. Perhaps a day after stripping it is recommended to saw imitation joints from both sides of the walls on neuralgic positions to allow possible shrinkage to “accumulate” in the joints and not show on the walls, as also done in CC when casting in situ.

As with all lightweight concretes (lesser with CC) hair-cracks might appear but have no adverse effect on the reinforcement, and usually disappear when painted. This way one complete house is cast each day with every set of vertical mould. Where applicable even the gable can be cast at the same time with appropriate modification to the mould.