Cellular Concrete for Road Constructon

Cellular or "Foamed Concrete" is currently used on a small scale in Ireland, mainly as 'Flowable Fill' for trench lines , but has the potential to provide economical solutions as part of Ireland's road building programme. Costing 25% to 30% less than regular concrete, possible applications include 'Base Stabilisation', Enhanced Berm Design' and 'Bank Stabilisation'. This article takes a brief look at cellular concrete and its unique properties.

Cellular Concrete is a lightweight material that solves many heavy-duty construction problems. Used beneath roadways, bridges, and ramps, buildings and other structures, it reduces soil loading while adding compressive and shear strength. In America and Japan in particular, contractors and engineers frequently use cellular lightweight concrete as backfill for tunnels, waterlines and sewers, to provide shock absorption in earthquake zones, to fill voids in silos and abandoned mines, to reduce hydrostatic pressure on walls and a myriad of other uses.

Composed of cement, water and small, discrete air cells, cellular concrete offers a unique range of benefits. Contractors can produce it quickly and easily on site by mixing a preformed foam into a Portland cement slurry. The first step is to make the preformed foam by diluting a foam concentrate with water. This mixture is then pumped through special equipment that adds fixed volumes of air at fixed pressures to create a material having the

Widening Highway in Japan

consistency of shaving cream. This material is mixed with cement and water in a conventional rotary mixer to distribute the air voids uniformly and form a highly stable cellular structure. Because production of preformed foam involves no gas-releasing chemical reactions, the foam doesn't expand once it enters the cement and the density remains constant. The cement paste attains initial set in about 90 minutes. Although the foam in the concrete matrix is stabilised after the initial set, six to ten hours must pass before a placement of cellular concrete can be topped by a subsequent lift.

The design of a cellular-concrete mix must balance the need for load reduction with compressive strength requirements. Because the material has a high air content, it generally has lower strengths than conventional concrete. (see table 1) Applications that need significant strength, such as foundations, may call for higher densities to achieve greater compressive strengths. For many applications however, such as flowable fill in trench lines or behind retaining walls, the compressive strength can be below 100 psi. Because cellular concrete flowable fill relies on large amounts of air rather than water for its fluid and self levelling qualities, the material bleeds less than conventional flowable fill concrete and shrinkage is almost negligible. The typical water cement ratio of cellular concrete ranges from 0.48 to 0.52.

Benefits of cellular concrete

- Generally lower in cost than alternative load-reduction methods
- Easily placed by pump or gravity for rapid installation
- Lightweight
- Durable and non corrosive
- Permanent and stable
- High slump (virtually self-levelling)
- Provides 100% compaction to fill spaces entirely without shrinkage
- Can have a broad range of densities and compressive strengths
- Absorbs shock waves
- High freeze thaw resistance
- Insulating (can contain up to 80% air)
- Low water absorption and permeability

Considerations when using cellular concrete

Although standard concrete (containing rock aggregate) and cellular concrete are similar in many ways, contractors must adapt their operations in the following ways when working with cellular concrete.

- Foam must be generated and mixed into the cement-water slurry on site. Forms, when used at all, can be much less complex than those used with standard concrete, saving time and money during pre-pour preparation.

- Cellular concrete must be pumped from the mixing station to the point of placement. Pumping can extend for great distances at rates exceeding 100 cubic yards per hour.

- Cellular concretes high slump makes it virtually self-levelling, which can eliminate or minimise spreading, raking, floating and other construction operations.

- The density and compressive strength of cellular concrete are controlled on site by varying the amount of foam injected. Density can be varied from 20 to 120 pounds per cubic foot and compressive strength from 20 to 3000 psi.

- The insulation afforded by air trapped in the cellular structure retains the heat of hydration, which eases cold weather placement and makes curing more complete.

- When pouring the material underwater, the mix must be designed for negative buoyancy and low washout.

Typical Cellular Concrete Applications

Highway and Road Construction
Base stabilisation
Enhanced berm design
Bank stabilisation

Parking Areas
Base Stabilisation for concrete and asphalt pavements

Geo-Tech & Underground
Local stabilisation Erosion control
Sound dampening
Land-use expansion
Mines & tunnels
Cavity and annular fill
Fire dampening
Area stabilisation

Construction
Bedding and Backfill for Uniform Support of Large Diameter Pipelines and Buried Tanks Foundations and fill for Fibreglass reinforced Plastic or steel tanks. Underground pipe insulation for hot and cold lines

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Cellular Concrete Density and Strength*

Cast Density** (lbs/cu ft)	Dry density** (lbs/cu ft)	Comp. Strength (lbs/sq.ins)	Bearing Capacity (tons/sq ft)
25	21	60	4.3
30	25	120	8.6
35	31	200	14.4
40	34	300	21.6
45	38	420	30.2

Table 1
* Actual properties depend on the cement used, water-cement ratio and other variables. Data is based on 28 days of curing.
** Accurate to plus or minus 3pcf.


Pumped Cellular Concrete