Foamed Cellular Light Weight Concrete

By
Kaushal Kishore, Materials Engineer, Roorkee

Foamed concrete, also called cellular light weight concrete is produced by the mixing of Portland cement, sand including or alone fly ash, water and preformed stable foam. The foam is produced with the help of a foam generator by using foaming agent. The air content is typically between 40 to 80 percent of the total volume. The bubbles vary in size from around 0.1 to 1.5 mm in diameter. Foamed concrete differentiates from (a) gas or aerated concrete, where the bubbles are chemically formed through the reaction of aluminium powder with calcium hydro oxide and other alkalies released by cement hydration and (b) air entrained concrete, which has a much lower volume of entrained air is used in concrete for durability. Curing of foamed concrete unit may be done as per IS: 456-2000. Curing can be speeded up by steam.

Foamed concrete may be produce by mixing the above mentioned ingredients in ready mix plant or ordinary concrete mixer. Foamed concrete is self compacting concrete requires no compaction, and will flow readily from a pump outlet to fill mould, form, restricted and irregular cavities. It can be pumped successfully over significant height and distances. The 28 days strength and dry density of the material vary according to its composition, largely its air voids content, but usually they range from 1.0 to 25.00 N/mm^2 and 400 to 1800 kg/m^3. The plastic density of the material is about 150 to 200 kg/m^3 higher than its dry density.

USES:

1. Foamed light weight concrete in the form of bricks, blocks or poured in-situ is used for thermal insulation over flat roofs or for cold storage walls or as non-load bearing walls in RCC/Steel framed buildings or for load bearing walls for low-rise buildings.
2. Fire rating of foamed concrete is far superior to that of brick work or dense concrete.
3. Bulk filling, using relatively low strength material, for redundant sewerage pipes, wells, disused cellars and basements, storage tanks, tunnels and subways etc.
4. Infill to the spandrel walls of arch bridges.
5. Backfill to retaining walls and bridge abutment.
6. Stabilizing soil, for example in the construction of embankment slopes.
7. Grouting for tunnel work.

BATCHING AND MIXING :

The dry ingredients like cement, sand, sand + fly ash or fly ash alone shall be fed into the mixer first and thoroughly mixed to ensure even distribution of cement. The appropriate amount of water shall be added thereafter continuing the mixing. The preformed foam, which is made by blending the foam concentrate, water and compressed air in predetermine proportion in a foam generator, calibrated for a specific discharge rate, shall be added in measured amount to the slurry of cement, sand, fly ash and water in the batch mixer. After an additional mixing to get uniform consistency, the slurry form of foamed cellular concrete of desired wet unit weight shall be ready to be poured out into forms/moulds etc. When truck mixing equipment is used for foamed concrete, the preformed foam shall be added at the job site just prior to pumping or otherwise conveying the concrete into forms.

The building blocks may be de-moulded after 24 hours from pouring of foamed concrete. Curing shall be done s per IS: 456-2000. To speed up the production, the blocks shall be cured by saturated steam at an average temperature of 460C ± 150C for a period of 24 hours or more to attained the required strength. After curing, the blocks shall be allowed to dry under shade for a period 2 to 3 weeks, so as to complete their initial shrinkage before being used in the work.

MIX DESIGN:

There is at present, no guidance or standard method for proportioning foamed concrete, because the hardened density of foamed concrete depends on the saturation level in its pores. Sample mix proportions of foamed concrete are given in table- 1, 2 & 3. However, conclusive mix proportions by actual trials may be worked out with the given set of site materials for required workability, plastic density and compressive strength.

Usually the OPC cement of foamed concrete lie between 300 to 500 kg/m^3 and W/C or W/C+FA ratio including the water in foam value will be between 0.4 to 0.8. The higher values are required with finer grained binders such as fly ash.

Table- 1. Sample mix proportion for cement, fly ash foamed concrete for first trial.

Required density (kg/m^3)	Required Compressive Strength at 28-day (N/mm^2)	W/C+FA ratio	OPC 53 grade (kg)	Fly ash (kg)	Water (kg)
800	2.5	0.50	350	183	267

1000	3.5	0.45	400	290	310
1200	6.5	0.40	450	407	343
1400	12.0	0.35	500	537	363

Table- 2 : Sample mix proportion for cement, sand foamed concrete for first trial.

Required density (kg/m^3)	Required Compressive Strength at 28-day (N/mm^2)	W/C ratio	OPC 53 grade (kg)	Fine sand passing 4 mm IS sieve (kg)	Water (kg)
1200	6.5	0.55	350	657	193
1400	12.0	0.50	400	800	200
1600	17.5	0.45	450	947	203
1800	25.0	0.40	500	1100	200

Table- 3: Sample mix proportion for cement, sand, fly ash foamed concrete for first trial:

Required density (kg/m^3)	Required Compressive Strength at 28-day (N/mm^2)	W/C+FA ratio	OPC 53 grade (kg)	Fly ash (kg)	Fine sand passing 4 mm IS sieve (kg)	Water (kg)
1200	6.5	0.55	294	126	549	231
1400	12.0	0.50	336	144	680	240
1600	17.5	0.45	378	162	817	243

1800	25.0	0.40	420	180	960	240

Note:

1. If superplasticizer is being used its dosage should not be more than 0.2 bwc.
2. Ignore the amount of water contained in the foam in the mix design calculation.
3. Determine the amount of air (kg/m^3) in the mix from consideration of a unit volume, and from the target density of the foam, estimate the required quantity of foam. Worked out final mix proportion for trials.
4. Usually the total cement content lie between 300 to 500 kg/m^3. The gain in strength is small above cement content of 500 kg/m^3.
5. Fly ash is added, at level of upto 100% of the OPC content, to enhance workability and increase long-term strength of foamed concrete. Because of greater surface area of OPC/FA mixes have a greater water demand than OPC/sand mixes. The addition of fly ash to a mix leads to a more uniform bubble structure in the paste, which in turn improve some of the engineering properties of the concrete.
6. Fly ash can be used as a total replacement for sand to produce foamed concrete with a dry density of upto 1400 kg/m^3.
7. In all cases trial mixes should be done with proposed materials to determine workability, plastic density, if need be the mix should be modified. Specimens shall be cast and tested for the compliance of required specifications.
8. To minimize shrinkage the W/C or W/C+FA ratio should be kept as low as possible.
9. Total fly ash based foamed concrete products are eco friendly as no sand is used.

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*We at engineeringcivil.com are thankful to **Sir Kaushal Kishore** for submitting his research paper on "Foamed Cellular Light Weight Concrete" to us. This will be of great help to all civil engineers seeking information on Light Weight Concrete.*

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