Transit Mix Perlite

Description
Perlite concrete aggregate combined with Portland cement, air entraining agent, and water produces an ultra lightweight concrete that is used for insulating roof decks and lightweight floor fills, insulating structural roof decks, curtain wall systems and for a variety of permanent insulating applications. An air entraining agent is used to improve the workability and to control water content and insulation value. Perlite concrete may be more accurately defined as concrete containing a minimum of 20 cubic feet of perlite concrete aggregate per cubic yard (.74m^3 perlite aggregate per cubic meter concrete).

Mixing Perlite Concrete
While perlite insulating concrete is mixed in the same equipment and by similar methods as sand-gravel concrete, there are some considerations that must be given to the order of addition of materials and to the time of mixing to assure correct concrete properties and adequate yield. The following mixing information for transit mixing is presented as a guide to the manufacturer to eliminate some of the questions that may arise in the field and to ensure successful construction with perlite concrete. When mixing perlite concrete on-site, in mechanical mixers, please refer to Publication 32-87, Perlite Insulating Concrete, Information for Contractors.

Transit Mixing
When transit mixing perlite concrete for the first time, it is suggested that the perlite manufacturer be consulted for suggestions as to the correct mixing time and procedure. These may vary with the type and age of locally available equipment.

The mixing procedure used by many transit mix operations is as follows:
(1) Determine the load of the mixer.
(2) Add to the mixer the correct amount of water for the load.
(3) Add the correct amount of air entraining agent and cement to the mixer and mix until a slurry is formed.
(4) Add the required number of bags of perilte concrete aggregate.
(5) Do not rotate the drum during transit.
(6) Upon arriving at the job site, mix at top speed for not less than 3 nor more than 5 minutes.
(7) Discharge in normal manner after checking wet density for conformance to specification range.
(8) Rotate the drum at idle speed when discharging last of load to assure complete discharge of concrete.
(9) Do not wash out drum between loads. Use the same trucks throughout the job.
(10) When mixing perlite concrete it is generally suggested that 100 to 150 revolutions of the transit mixer drum will give good perlite concrete. This varies with the age and effectiveness of equipment.

If possible, the drum should be charged with water, air entraining agent and cement at the batching plant, and the perlite aggregate should be added at the job site, mixing at high speed until the desired density and consistency is reached.

Care must be taken to ensure proper mixing time for the perlite insulating concrete. Using the correct amount of water as specified, the perlite concrete should have a slump of approximately 7 inches (18 cm) when properly mixed and may appear too wet by normal concrete practices. However, if the mix appears too dry or stiff, the mixing time has probably been too short. Continue mixing until the desired plasticity is reached. Extra water and under mixing may reduce the yield.

The first truck load of perlite concrete will usually discharge about one third of a yard short since this quantity will coat the inner walls of the truck drum. However, this will not occur in subsequent loads, because the walls will be coated sufficiently. After discharging the last load, 7-10 gallons (26-38 liters) of water may be added to the revolving drum to wash out this coating and this mixture may be dumped and blended with other concrete from the previous load. This will not impair the perlite concrete properties because the excess water bleeds out without loss of cement.

Wet Density

The wet density of perlite insulating concrete as poured is important in the control of the physical properties of the dry concrete and the yield achieved. The strength and the insulating value depend on the wet density. Heavier weight means greater strength and less insulation. Therefore, the architect or engineer usually specifies the wet density of the perlite concrete with a plus or minus 3 lb/ft^3 (48 kg/m^3) range.

Field Control

The wet density can be checked for conformance to the architects specifications beginning with the first truck load delivered. Adjustments to the mixing procedure should be made at hat time and additional checks made periodically during pouring.

The simplest method of field checking wet density is as follows:

1. Determine the exact volume of a cylindrical container such as a rigid 10 quart (10 liter) container. This can be done by first weighing the empty container, then filling it level full with water and weighing it again and subtracting the two weights. This provides the net weight of the contained water, and, if divided by the density of water, the result is the exact volume in the container.

EXAMPLE:

Weight of empty container	2.0 lbs
Weight of container filled with water	23.0 lbs
Net weight of water	21.0 lbs

$$\text{Volume} = \frac{\text{Net Weight of Water}}{\text{Density of Water}} = \frac{21 \text{ lbs}}{62.4 \text{ lb/ft}^3} = 0.336 \text{ ft}^3$$

EXAMPLE: (Using metric units)

Weight of empty container	.91 kg
Weight of container filled with water	10.45 kg
Net weight of water	9.54 kg

$$\text{Volume} = \frac{\text{Net Weight of Water}}{\text{Density of Water}} = \frac{9.54 \text{ kg}}{999 \text{ kg/m}^3}$$

$$= .00955 \text{ m}^3$$

2. Fill the container with wet perlite concrete as it leaves the mixer and weigh again. Subtract the weight of the empty container and divide the remainder by the volume as determined in Step 1. The result is the wet density of die perlite concrete in pounds per cubic foot which should be within ± 3 lb/ft^3 (48 kg/m^3) of the specified value.

EXAMPLE: (1:6 mix)

Weight of container filled with concrete	15.5 lbs
Weight of empty container	2.0 lbs
Weight of perlite concrete	13.5 lbs

$$\text{Wet Density} = \frac{\text{Weight of Perlite Concrete}}{\text{Volume}} = \frac{13.5 \text{ lbs}}{0.336 \text{ ft}^3}$$

$$= 40.2 \text{ lbs/ft}^3$$

The specified wet density of the 1:6 mix (94 lbs of Portland cement to 6 ft3 of perlite aggregate) is 40.5 ± 3.0 lb/ft^3. Therefore, the field test wet density is within the specification range.

EXAMPLE: (Using metric units)
(A mix with typical wet density of 40.5 ± 3 lb/ft^3=648 ± 48 kg/m^3)

Weight of container and perlite concrete	7.05 kg
Weight of empty container	.91 kg
Weight of perlite concrete	6.14 kg

$$\text{Wet Density} = \frac{\text{Weight of Perlite Concrete}}{\text{Volume}} = \frac{6.14 \text{ kg}}{.00955 \text{ m}^3}$$

$$= 643 \text{ kg/m}^3$$

Therefore the field, test wet density is within the 648 ± 48 kg/m^3 specification range.

Air Entraining Agent

The use of the correct amount of air entraining agent of the proper concentration is of extreme importance in successful perlite concrete construction. The air en- training agent produces countless tiny air bubbles in the concrete, which reduces the density, increases the yield and contributes to the insulation value of the dry concrete. Air entrained concrete is also more resistant to water absorption.

Care should be taken in mixing perlite concrete to ensure that the proper amount of agent is sued. Excess air entraining reduces the strength of concrete. An even distribution of agent is also essential to produce the desired concrete characteristics.

Placement of Perlite Concrete

Perlite concrete may be placed through the use of crane and bucket or by pumping. The preferred method is by pumping. A progressive cavity pump is recommended as this type pump will not place undo pressure on the perlite. In addition, a pump hose should be minimum of 3 inches in diameter. Hose kinking should be avoided. Hoses should be tied off at each joint.

Yield

Yield is defined as the ratio between the volume of the wet perlite concrete as discharged from the mixer and the volume of perlite concrete aggregate used in the mix. The mix proportions included in the specifications are based on extensive field and labortory tests and are established for 100% yield. If the correct quantities of material and mixing procedure are used, a 100% yield should result. Yield may vary however as it is effected by job site conditions including mixing time, fineness of aggregate, pumping equipment, height to be pumped, length of hose, etc.

Field Cheek for Yield

The first step necessary in making a field check for yield is to determine the wet density of the perlite concrete as previously outlined.

The wet density and the weight of total ingredients for tile mix being used are then substituted in the following formula:

(a) $$\frac{\text{Weight of Total Ingredients}}{\text{Wet Density of Concrete}} = \text{Yield}$$

(b) $$\frac{\text{Yield}}{\text{Volume of Perlite Aggregate}} \times 100 = \%\ \text{Yield}$$

EXAMPLE:
Consider a 1:6 mix (94 lbs of cement to 6 ft^3 of perlite) The wet density as determined in Example No. 1 is 40.2 lb/ft^3.

The weight of total ingredients is as follows:

Portland cement	94.0 lbs
Perlite- 6 ft^3@8.0 lb/ft^3	48.0 lbs
Water-12 gallons @ 8.33 lbs/gal	99.96 lbs
Air Entraining Agent-1.5 pints @ 1 lb/pint	1.5 lbs
Total	243.46 lbs

Substituting in formula (a):

$$\frac{243.46 \text{ lbs}}{40.2 \text{ lb/ft}^3} = 6.05 \text{ ft}^3 = \text{Yield}$$

Substituting this value in formula (b):

$$\frac{6.05 \text{ ft}^3}{6 \text{ ft}^3} \times 100 = 101\%$$

EXAMPLE: (Using metric units)
Consider a mix of 42.73 kg to 6 ft^3 of perlite (.17 m^3). The wet density as determined in the Example is 643 kg/m^3. The weight of total ingredients is as follows.

Portland cement	42.73 kg
Perlite-.17 m^3 @ 128 kg/m^3	21.78 kg
Water-45.42 liters	45.44 kg
Air entraining agent-708 ml	.68 kg
Total	110.63 kg

Substituting in formula (a):

$$\frac{110.63 \text{ kg}}{643 \text{ kg/m}^3} = .172 \text{ m}^3 = \text{Yield}$$

Substituting this value in formula (b):

$$\frac{.172 \text{ m}^3}{17 \text{ m}^3} \times 100 = 101\%$$

Loss of Yield

If the yield as checked by the wet density is less than 100%, a loss of yield is evident. A loss of yield may be attributed to a number of factors as previously noted. However, one or more of the following factors should be checked.

Air Entraining Agent- Be sure that the proper amount is being added to each batch. Check concentration.

Mixing Procedure and Time- Be certain that mate- offset the effect of the air entraining agent and materials are added in the proper sequence. Under mixing require adjustment of the quantity of air entraining will usually result in loss of yield while overmixing can adversly affect the air entrainment.

Water-Check the amount of water being added. After one minute of mixing, properly proportioned perlite concrete often looks too dry. If extra water is added, yield can be reduced. Hard water will often offset the effect of the air entraining agent and may require adjustment of the quantity of air entraining agent.

Mix Design Data- The proper proportions of materials for various perlite concrete mixes are show in Table 1. The importance of properly designing and specifying the mix and the proper use of the air entraining agent cannot be overemphasized.

Table 1a-Materials per Cubic Yard Based on 100% Yield

Mix Ratio (Cement/ Perlite Aggregate) Volume	Oven Dry Density (Typical) lb/ft^3	Cement Bags	Perlite ft^3	Water Gallons	Air Entraining Agent	Wet Density Range lb/ft^3
1:4	36	6.75	27	61	*	50.5±3.0
1:5	30.5	5.40	27	59.5	*	45.5±3.0
1:6	27	4.50	27	54	*	40.5±3.0
1:8	22	3.38	27	54	*	36.5±3.0

Table 1b-Materials per Cubic Meter Based on 100% Yield

Mix Ratio (Cement/ Perlite Aggregate) Volume	Oven Dry Density (Typical) kg/m^3	Cement kg	Perlite m^3	Water m^3	Air Entraining Agent	Wet Density Range kg/m^3
1:4	576	376	1.0	.30	*	808.0±48.0
1:5	488	301	1.0	. 29	*	728.0±48.0
1:6	432	252	1.0	.27	*	648.0±48.0
1:8	352	188	1.0	.27	*	584.0±48.0

* Consult perlite manufacturer or building supply dealer for recommended type and quantity of air entraining agent.

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