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Felt Tips

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ASTM C90, A White Paper Type I vs. Type II Block

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The decision of whether to specify Type I or Type II concrete masonry units per ASTM C90 has long been a dilemma for both the concrete masonry producer and the design professional. On the surface, it would seem that to specify a Type II unit would be to specify an inferior block. Nothing could be further from the truth! Recently, an ASTM Study Committee proposed including a linear shrinkage requirement of 0.065 for Type II units, to remove the stigma of inferiority from the Type II block. This requirement will be included in the next revision, probably in 1994. Although this change is meant to help the design professional in his specification writing, a far better decision would have been to remove Table 1 and Type I, moisture controlled units from ASTM C90 entirely and have only one type of block without linear shrinkage requirements.

To better understand this situation, some history must be studied, including why the linear shrinkage table was inserted in ASTM C90 in the first place. Carl Menzel, while working for the Portland Cement Association from 1931 to 1935, developed a high pressure steam curing process called autoclaving. This method of curing uses large cylindrical pressure vessels that subject the block to temperatures of 325 to 375 degrees F [163 to 190 degrees C] for various times up to 12 hours. At the end of the steaming interval, if the condensate is drained and the cylinder pressure is reduced as rapidly as possible, 20 to 30 minutes, the stored heat quickly lowers the absorbed moisture content. This procedure brings the units to specification requirements. This would seem, then to be the perfect answer to curing concrete masonry units, except that the cost of curing is extremely high in relation to low pressure steam curing.

Those plants that spent the time and money to install autoclave curing, found there was nothing in ASTM that design professionals could use to justify specifying autoclave block over low pressure steam cured units. The producers, them went to their national association, NCMA, to get something inserted in ASTM C90 that would give them a selling advantage over low pressure steam curing plants. The result was the insertion of Table 1 for linear shrinkage, the designation of Type I, moisture controlled units and Type II, non-moisture controlled units in ASTM C90

TABLE 1
Moisture-Content Requirements for Type I Units

Linear Shrinkage, Percent	Moisture Content, Maximum Percent of Total Absorption (Average of 3 Units)		
	Humidity Conditions at Job Site or Point of Use		
	Humid[A]	Intermediate[B]	Arid[C]
0.03 or less	45	40	35
From 0.03 to 0.045	45	35	30
0.045 to 0.065, maximum	35	30	25

[A] Average annual relative humidity above 75 percent.
[B] Average annual relative humidity 50 to 75 percent.
[C] Average annual relative humidity less than 50 percent.

Over the years, the high cost of autoclave curing cased most of the producers to abandon this type of curing and revert to low pressure steam curing. The end result, is, that from a high of 205 autoclave plants in 1965, only a handful of autoclave plants still exist in today's market. The linear shrinkage requirements and Type I and Type II block still remain in ASTM C90, however, causing no end of problems. Block cured by the autoclave method still have the same ability to absorb moisture as do block cured by the low pressure steam curing process. This means, that in order to reduce shrinkage in the wall, the block would have to be covered in the block plants storage facility, covered on the delivery truck, covered on the job site and covered in the wall until some protection can be applied to the wall to prevent moisture penetration. A far better way to control shrinkage in the wall is the proper location and spacing of control joints and not be depending on the low absorption abilities of the block itself.

For years we have recommended control joint locations at pilasters, intersecting walls, over openings, at changes in wall heights, 10 feet [3300 mm] from corners and 20 to 25 feet [6000 to 7600 mm] between control joints. This practice has virtually eliminated cracking due to shrinkage, and we have done so with so called non-moisture controlled, or Type II block. It has been the practice of specifiers using moisture controlled or Type I block, to increase the spacing of control joints to 25 feet from the corners and 50 feet [15 000 mm] between control joints. This practice of depending on the moisture controlled units per ASTM C90 to control shrinkage cracking has not done as well as additional control joints in eliminating cracking due to shrinkage. As a matter of fact, along the East coast, with certain types of aggregate, shrinkage cracking is a major problem with the longer spacing between control joints.

The test for linear shrinkage and Type I moisture controlled units is ASTM C426 which covers a standardized procedure for determining the drying shrinkage under specified accelerated drying conditions. However, the test requires precise measuring equipment graduated to read in 0.0001-inch [0.00254 mm] units and accurate within 0.0001 inches [0.00254 mm] in any 0.0010 inch [0.0254 mm] range, and to get the block to equilibrium takes anywhere from 30 to 45 days.

The procedure for running ASTM C2\426 begins with immersing the specimen for the drying shrinkage determination in water at 73.4 degrees F for 48 hours.

Next, obtain the initial-length reading on the specimen being careful to avoid error due to cooling by evaporation.

Then obtain the saturated surface-dry weight of the test specimen draining it for one minute over a 3/8 inch [9.5 mm] mesh and removing visible surface water by blotting with a damp cloth.

Store the specimen for drying in the oven. To ensure uniformity of drying, the individual specimens should be rotated to different positions in the drying oven each time readings are taken.

At the end of 5 days drying, including any period of preliminary drying in air up to 48 hours, remove specimens from drying oven and cool to 73.4 degrees F [23 degrees C]. Following cooling, obtain specimen-length reading and weight.

Return test specimens to the drying oven for a second period of drying. The second and subsequent drying periods shall last for 48 hours. Following the second period of drying, repeat cooling, length readings and weight determination.

Continue the 48 hour periods of drying in the specimen oven, followed by length and weight determinations after cooling until an equilibrium condition of the shrinkage specimens has been reached. This testing, to reach an equilibrium condition, takes from 30 to 45 days. Unfortunately, after all this time and effort, you still have a block that has a water absorption rate from 13 to 18 pounds per cubic foot [208 to 288 kg/m^3], depending upon the aggregate used and the unit weight of the block. This means the units will shrink andre-expand in the wall as moisture and temperature conditions change and also why control joints must be used to control the cracking that would result from this movement.

Consequently, then, since control joints are required in any event, and since we know that proper location and spacing of these control joints will eliminate shrinkage cracking, why do we bother with this tedious and worthless ASTM test for drying shrinkage? It would be far better to specify Type II units with good control joint locations and spacing, and feel confident our concrete masonry walls will perform as expected. This also would enable the design professional to properly control the job rather than depend on the ability of the units to reduce shrinkage and on a laboratory test to give false confidence.

Both ASTM Type I and Type II units meet all of the other requirements of ASTM C90 will perform equally well in buildings as long as good control joint locations and spacing as well as good design principles are adhered to. Both, however, can crack due to shrinkage, if these criteria are not used. Whether a unit passes the linear shrinkage requirements of ASTM C90 or not, really has little bearing on how well the unit performs in the wall. Design principles are really the main factor in reducing shrinkage cracking. Peace of mind will only come when design professionals rely on proper design of control joints to reduce shrinkage cracking. Depending on a laboratory test to do this will not accomplish the desired results.

TABLE 2 Strength and Absorption Requirements

Note: To prevent water penetration, protective coating should be applied on the exterior face of basement walls and when required on the face of exterior walls above grade.

Grade	Compressive Strength, minimum, psi (MPa)		Water Absorption, maximum, lb/ft^3 (kg/m^3) (Average of 3 Units) with Oven-dry Weight of Concrete, lb/ft^3 (kg/m^3)			
	Average Gross Area		Weight Classification			
	Average of 3 Units	Individual Unit	Light Weight		Medium weight Less than 125 to 105 (2002 to 1682)	Normal weight 125 (2002) or More
			Less than 85 (1362)	Less than 105 (1682)		
N-I	1000 (6.9)	800 (5.5)	- - -	18 (288)	15 (240)	13 (208)
N-II						
S-I[A]	700 (4.8)	600 (4.1)	20 (320)	- - -	- - -	- - -
S-II[A]						

[A] Limited to use above grade in exterior walls with weather-protective coatings and in walls not exposed to the weather.

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