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Mortar Mixes

Here are seven common and uncommon mortar mixes. They are types N, M, S and O. There is also mortar for glass block, straight lime mortar and type K. Type K is used solely in historic preservation. Each one has a certain proportion of Portland cement, hydrated lime and sand. Mortar proportions are always expressed in that order. Plus, these proportions always refer to volumes, not to weight or a combination of volumes and weights. But then, the components of these mixes are usually purchased by weight but that's not how the mixes are measured.

A mix designated as 3/1/12 has 3 parts of Portland cement, 1 part hydrated lime and 12 parts sand. Now let's say that you want to compute mortar by the cubic yard. So how much of each mortar component is in a cubic yard? Let's go through all seven of the mixes and see.

Be aware that the proportions of lime, cement and sand in each mix type can vary a bit by geographic regions or by contractors within a region. However, we are showing you the commonly used proportions and if you are used to something a little different, then you are simply using a regional or personal variation on the standard.

Also, these amounts are designed to add up to exactly one cuyd of material. Field amounts can show other quantities of components due to the realities of outdoor mortar mixing. Much of the literature on mortar proportions and mixes show greater or different quantities due to the great amount of waste in the actual preparation, transportation within the job site and handling during the use of a batch of mortar. The numbers shown here reflect computed amounts. These are exact mathematical measurements down to the spoonful (though we give you final amounts of sand in tons and the other parts in bags). The tons and bags are finely measured. The terms **hydrated lime** and **lime putty** mean the same thing since lime putty is simply wet hydrated lime (you added some water to it and stirred it up) whereas in hydrated lime all of the water molecules are stoichiometrically bonded to the calcium and magnesium in the lime and the lime remains a dry powder. Lime putty is just wet hydrated lime.

The mix calculations use densities set out by the **ASTM**. These are:

Portland cement	**94 lbs/cuft**
Hydrated lime	**40 lbs/cuft**
Sand	**80 lbs/cuft**

The purchased items are by these:

Portland cement	**94 lb bags**
Hydrated lime	**50 lb bags**
Sand	**by the ton**

Component amounts

Type N mortar

This uses a 1 / 1 / 6 mix and results in a mortar with a 750 psi compressive strength. Type N is the normal, general purpose mortar mix and can be used in above grade work in both exterior and interior load-bearing installations.

To get 1 cuyd of N mortar, you need 27 cubic feet of the components in a 1 to 1 to 6

proportion.

Portland cement **3.375 cuft**

Hydrated lime **3.375 cuft**

Sand **20.25 cuft**

Total **27 cuft**

Based on the ASTM densities, this gives you 317.25 lbs of Portland cement, 135 lbs of hydrated lime and 1,620 lbs of sand.

To put together a single cubic yard of type N mortar, you need to buy and mix together:

3.375 bags of Portland cement (94 lb bags)

2.7 bags of hydrated lime (50 lb bags)

0.81 tons of sand

Type M mortar

This uses a 3 / 1 / 12 mix and results in a mortar with a 2,500 psi compressive strength. Type M is used for below grade load-bearing masonry work and for chimneys and brick manholes.

To get 1 cuyd of M mortar, you need 27 cubic feet of the components in a 3 to 1 to 12 proportion.

Portland cement **5.0625 cuft**

Hydrated lime **1.6875 cuft**

Sand **20.25 cuft**

Total **27 cuft**

Based on the ASTM densities, this gives you 475.875 lbs of Portland cement, 67.5 lbs of hydrated lime and 1,620 lbs of sand.

To put together a single cubic yard of type M mortar, you need to buy and mix:

5.0625 bags of Portland cement (94 lb bags)

1.35 bags of hydrated lime (50 lb bags)

0.81 tons of sand

Type S mortar

This uses a 2 / 1 / 9 mix and results in a mortar with a 1,800 psi compressive strength. Type S is used for below grade work and in such areas as masonry foundation walls, brick manholes, retaining walls, sewers, brick walkways, brick pavement and brick patios.

To get 1 cuyd of S mortar, you need 27 cubic feet of the components in a 2 to 1 to 9 proportion.

Portland cement **4.5 cuft**

Hydrated lime **2.25 cuft**

Sand **20.25 cuft**

Total **27 cuft**

Based on the ASTM densities, this gives you 423 lbs of Portland cement, 90 lbs of hydrated lime and 1,620 lbs of sand.

To put together a single cubic yard of type S mortar, you need to buy and mix:

4.5 bags of Portland cement (94 lb bags)

1.8 bags of hydrated lime (50 lb bags)

0.81 tons of sand

Type O mortar

This uses a 1 / 2 / 9 mix and results in a mortar with a 350 psi compressive strength. Type O is a lime rich mortar and is also referred to as "pointing" mortar. It is used in **above grade**, **non-load bearing** situations in both interior and exterior environments.

To get 1 cuyd of O mortar, you need 27 cubic feet of the components in a 1 to 2 to 9 proportion.

Portland cement **2.25 cuft**

Hydrated lime **4.5 cuft**

Sand **20.25 cuft**

Total **27 cuft**

Based on the ASTM densities, this gives you 211.5 lbs of Portland cement, 180 lbs of hydrated lime and 1,620 lbs of sand.

To put together a single cubic yard of type O mortar, you need to buy and mix together:

2.25 bags of Portland cement (94 lb bags)

3.6 bags of hydrated lime (50 lb bags)

0.81 tons of sand

Type K mortar

This uses a 1 / 3 / 10 mix and results in a mortar with but a 75 psi compressive strength. Type K is useful only in historic preservation situations where load bearing strength is not of importance and the porous qualities of this mortar allows very little movement due to temperature and moisture fluctuations. This aids in prolonging the integrity of the old or even ancient bricks in historic structures.

To get 1 cuyd of K mortar, you need 27 cubic feet of the components in a 1 to 3 to 10 proportion.

Portland cement **1.93 cuft**

Hydrated lime **5.79 cuft**

Sand **19.29 cuft**

Total **27 cuft**

Based on the ASTM densities, this gives you 181.42 lbs of Portland cement, 231.6 lbs of hydrated lime and 1,543.2 lbs of sand.

To put together a single cubic yard of type K mortar, you need to buy:

1.93 bags of Portland cement

4.632 bags of hydrated lime

0.7716 tons of sand

Straight lime mortar

This uses a 0 / 1 / 3 mix and is used now only to recreate the construction and review the methods of times past or maybe for purely visual purposes. This mortar was made before Portland cement was available in many areas and so this is what was used. Sometimes you'll see straight lime mortar called "L" mortar (for **lime**) but this is not designating it as "type L" mortar as in the MSNOK types. There is no "type L" mortar.

To get 1 cuyd of lime mortar, you need 27 cubic feet of the components in a 0 to 1 to 3 proportion.

Portland cement	**none**
Hydrated lime	**6.75 cuft**
Sand	**20.25 cuft**
Total	**27 cuft**

Based on the ASTM densities, this gives you no Portland cement, 270 lbs of hydrated lime and 1,620 lbs of sand.

To put together a single cubic yard of lime mortar, you need to buy:

No bags of Portland cement

5.4 bags of hydrated lime (50 lb bags)

0.81 tons of sand

Glass block mortar

This uses a 1 / 1 / 4 mix and is used with as little water as possible. This is a mix designed specifically for glass block. Also, note that it uses **waterproof** Portland cement in place of "regular" Portland cement.

To get 1 cuyd of glass block mortar, you need 27 cubic feet of the components in a 1 to 1 to 4 proportion.

Waterproof Portland cement	**4.5 cuft**
Hydrated lime	**4.5 cuft**
Sand	**18 cuft**
Total	**27 cuft**

Based on the ASTM densities, this gives you 423 lbs of waterproof Portland cement, 180 lbs of hydrated lime and 1,440 lbs of sand.

To put together a single cubic yard of glass block mortar, you need to buy and mix:

4.5 bags of Portland cement (94 lb bags)

3.6 bags of hydrated lime (50 lb bags)

0.72 tons of sand

Note

Lime types versus Mortar mix designations

Limestone formed by nature contains varying proportions of calcium to magnesium. No large scientist with a giant beaker and a set of stoppered test tubes measured out the things that make up rocks beforehand. Some of it has more magnesium while other limestone rock has more calcium. For making mortar, it is desirable to have from a third to a half of the rock from which the mortar lime is derived composed of magnesium carbonate. The remainder then would be from one half to two thirds calcium carbonate. A limestone whose composition falls within these percentages is **dolomitic limestone** and from it is made **Type S** lime hydrate. Masonry lime made from limestone that is composed of less than 5% magnesium carbonate (called **high calcium limestone** since it is 95% to 99% calcium carbonate) is labeled Type N lime hydrate. Type S lime is used to make masonry mortar. **Type N** lime can be used only if it is tested and proven on a batch by batch basis. The type **S** lime designation stands for **S**pecial and the type **N** stands for **N**ormal. The special lime hydrate is the one normally used and the normal lime hydrate is used only with special testing. These lime "types" have absolutely nothing to with mortar mixes type N and type S. You must never, ever confuse these lime hydrate types with mortar mixes. They have nothing to do with one another. Why "they" should label them with the same designations, we have no idea.

Mason Work

The five typical mortar mixes designated types **M,S,N,O** and **K** are labeled so because each is an alternate letter in the term **MASON WORK** in descending psi strength. These designations were assigned in 1954 and replaced the mortar designations A-1, A-2, B and C.

M 2,500 psi

A

S 1,800 psi

O

N 750 psi

W

O 350 psi

R

K 75 psi

Know that a weaker psi mortar is not a "bad" or inferior mortar to one with a higher psi. A lower psi mortar has much better adhesive and sealing powers than a higher one. Mortars are selected on the balance between these attributes as to what is required for the building situation on a particular spot in the job. A type M mortar with its high strength yet poor adhesion and sealing can be a bad choice for one area of the job and just what is needed in another.

Minimum compressive mortar strengths, ASTM and its psi requirements

The ASTM assigns minimum required compressive strengths to the various mortar types. To meet the minimum psi requirements, a mix just has to be at or above the psi. It can be greatly above the psi. It only has to meet or beat the minimum psi.

Here are the ASTM minimums:

Type M	2,500 psi
Type S	1,800 psi
Type N	750 psi
Type O	350 psi
Type K	75 psi

But, be aware that the mix listed for type N mortar typically achieves a 28 day strength in the range of 1500 to 2400 psi. This meets and beats the ASTM requirement of 750 psi by a great deal.

Another example is the mix listed for type O mortar provides a usual psi in the range of 750 to 1200 and higher, sometimes up to 2000. Again, this meets the minimum psi of 350 by a large percentage.

Typical type M mixes have strengths of 3000 to 3800 psi and so exceed the ASTM minimum compressive strength requirement of 2500 psi.

Type S mortars are required to have a minimum of 1800 psi and their mixes usually give you strengths of from 2300 to 3000 psi.

So, if you are involved in the historic preservation of masonry and need to be concerned not with a mortar's minimum strength but with its maximum strength, you need alternate mixes to obtain mortars with a wanted maximum strength. Remember, the ASTM requirements are for minimum psi's and the normal mix ratios for types M, S, N, O and K exceed, sometimes by a great amount, the minimum compressive strengths.

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