Homemade Insulating Castable Refractory for Use Over a Sprung Arch
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This homemade insulating castable is not appropriate for hotface use inside a kiln. I designed it for the 4" insulating layer to go over a brick sprung or catenary arch, and it works very well for that. It might work for lower temperature hotface applications like a pizza oven, but you'd have to test it before building such an oven. For higher temperature use, you'd need to substitute calcium-aluminate cement for the Portland cement, and grog rather than sand. You'd definitely want to cast a few brick-size blocks and test fire them to the desired temperature to determine the fired stability and durability.

In the past I have always made this castable with sawdust or vermiculite as the insulating media rather than perlite, and have never included Portland cement. I am always trying to improve things, and thus have experimented with different formulas. Vermiculite is expanded mica, and perlite is expanded silica. In potting soil mixtures, you may have noticed little white granules that look like Styrofoam. That's perlite. Vermiculite really doesn't work very well, because it cleaves and compresses so easily and loses most of its volume and insulating air content in the cement mixer while preparing the mix. Sawdust works if you can find a good source of coarse sawdust. You do not want powder, nor do you want chips and shavings. Crushed, graded walnut shells work well if you can get them, but with sawdust or walnut shells, the insulation layer over an arch will release considerable smoke, lessening over a period of years. The layer doesn't get hot enough for all the combustibles to burn out in the first firing, so it happens slowly with each firing, and that smoke smell can be very bothersome. Four 4-cubic-foot bags of perlite will cost you about $100, and that is a small price to pay to eliminate the smell of burning sawdust. Crushed walnut shells will cost as much or more than perlite.

The addition of Portland cement makes the insulating layer weatherproof and much more durable, and since the Portland cement air-sets in a day or two, the mix doesn't shrink and crack as it dries. If you are using this castable in a covered shed where it will not get wet, you can omit the Portland cement if you wish. Without it, the mix will crack as it dries. When that happens, just fill the cracks with more of the same mix.

Required Materials
This amount is for the insulating layer over the arch of a sprung-arch kiln of 20-30 cubic feet. Adjust the amount proportionally for a larger or smaller kiln.

- 4 – 50# bags of Fireclay
- 4 – 4-cubic-foot bags of perlite – these are huge bags, but they weigh very little. They are available from any good nursery. Find the big 4-cubic-foot bags, because it will be far more economical than purchasing the required amount in smaller bags. You really do need this quantity.
- 2 – 50# bags of cheap builder's or playground sand (available from Lowe's or Home Depot)
- 2 – 50# bags or 1 – 100# bag of Portland Cement
- 2 – one-gallon plastic buckets (one to measure water, one to measure dry materials)
- Durable rubber gloves for anyone who will be handling the castable
- A good wheelbarrow
- A cement mixer or preferably a mortar mixer

- Several buckets approximately two gallons for scooping the mix out of the wheelbarrow and dispensing it atop the arch. Do not use the same buckets you are using to measure out the dry materials.

For preparing any significant quantity of this mix, borrow or rent a cement mixer. Get a mortar mixer if you can. Regular cement mixers have a rotating, tilted barrel, whereas a mortar mixer has a stationary bin with a rotating horizontal shaft through the center carrying the impeller blades. A mortar mixer does a far better job of mixing fairly stiff castable. Also, the mortar mixer bin tilts on the same axis as the shaft, and it is very easy for one person to dispense the contents into a wheelbarrow. With a conventional cement mixer, it usually takes two people to do that.

Recipe for Non-Hot-Face Castable Insulating Refractory

This recipe is by parts, not pounds. It could be scoops, or buckets, measuring cups, or any other convenient measuring container depending on the quantity you are making. One-gallon buckets work best for quantity required here.

- 2 parts fireclay
- 1 part cheap builder's sand
- 1 part Portland cement
- 14 parts perlite

To Prepare the Mix:

The amount you can mix per mixer-load will depend on the size of mixer. The following is for a small cement mixer. For a mortar mixer or a large cement mixer, double the amounts.

- Lock the mixer in the mixing position. For a conventional cement mixer, the barrel will be inclined at about a 45-degree angle. For a mortar mixer, the bin will be vertical. ***With a mortar mixer, make sure that the hinged grate cover remains securely closed over the top of the bin whenever the mixer is operating, and do not ever insert your hands or tools through the openings in the grate cover. Do not neglect this, because mortar mixers are capable of inflicting catastrophic or fatal traumatic injury***. You can pour water and dry materials in through the grate cover.
- Turn on the mixer and leave it operating for the entire mixing operation for each batch.
- Add four gallons of water. The mix will need more water as you proceed, so monitor the consistency as indicated below.
- Add **two** one-gallon buckets of fireclay. Be sure to add the fireclay before the other materials.
- Add **one** one-gallon bucket of sand
- Check the mix for consistency. If it is still fairly fluid, flowing around the mixer blades, it is fine.
- Add **one** one-gallon bucket of Portland cement.
- Check the mix for consistency, and add more water if it is getting sluggish.
- A few buckets at a time, add 14 one-gallon buckets of Perlite, frequently checking the consistency of the mix. When it gets too sluggish, add a little more water with a hose and allow it to blend for a while before adding more perlite. This might seem like a huge amount of perlite, but some of it will collapse and compact, so the quantity is necessary to end up with a castable that still has good insulating properties.

- The objective is a mix that flows very sluggishly. If it is too fluid, it will probably crack as it cures, and it will be difficult to handle and put in place.
- If you get to this point and the mix seems too fluid, add small proportional amounts of fireclay, sand, Portland cement and perlite to stiffen it up a bit.
- Put the wheelbarrow in place and tilt the mixer with it still operating, allowing the mix to flow into the wheelbarrow.
- Turn off the mixer, and ***unplug it if it is electric***.
- ***If a mortar mixer, raise the grate cover and lock it securely in the raised position or have someone securely hold it in the raised position***. Don't take chances with this. If the grate cover falls on you, it can cause very serious injury. ***Mortar mixers do a far better job than a standard cement mixer, but can only be used if these essential precautions are taken***.
- Wearing rubber gloves and using a trowel or spatula, scrape away as much of the mix as possible from the inside of the mixer and the impeller blades, adding it to the wheelbarrow.

Apply the insulating castable to the top of the arch right away. This mix contains Portland cement, which will begin setting up before long, so time is of the essence. Just scoop the mix out of the wheelbarrow with two-gallon buckets, dump them onto the arch, and work the castable into place (wearing the rubber gloves). If mixed properly, it will stay where you put it and will not flow. When I used this mix for the insulating layer on top of a 30-cubic foot sprung-arch soda kiln, it took four double-batches in a mortar mixer to apply a 4" layer over the arch all the way out to the edges. I was easily able to handle a full double-batch in a contractor's wheelbarrow.

When the insulating layer is all in place, gently slap the surface with your hands (wearing the rubber gloves). This will "puddle" the mix, bringing moisture to the surface, and you will end up with a very nice surface. Don't get carried away, because if you slap and puddle it too much the castable may start to flow. If this happens, leave it alone for an hour or so and then finish the surface.

Since this is an insulating castable, it is a very open, well-ventilated mix, and the kiln can be fired as soon as the Portland cement cures. Give it 48 hours to thoroughly cure and harden. The moisture will still be present in the castable, just as it is in cast concrete. Firing will dry the castable, producing a lot of steam, but the steam will escape with no problem. Normally, solid-cast Portland cement cannot be heated up without popping or exploding, which is why a kiln floor atop a concrete slab is always at least three layers of firebrick. This mix contains only 10% Portland cement, and with so much sand and perlite opening up the mix, it can be heated very quickly with no chance of trapped steam. If you ever make a high-temperature hotface version of this castable using calcium-aluminate cement rather than Portland cement, it should initially be fired very slowly. One option in that case is to cast component blocks and pre-fire them in a separate kiln.