APPLICATION PROCEDURE FOR REFRACTORY CASTABLE, LOW CEMENT,ULCC & INSULATION CASTABLE

1. Storage: Store Castable under covered shed, on pallets stack 15 high Max
2. Surface Preparation:

- The work surface shall be substantially free of dust.scale, oil water and loose foreign material and shall be cleaned by wire brush or sand blasting if necessary.
- Use plywood or steel formers; make the joints watertight using polythene tape.
- Height of formers not to exceed 1000 mm.

3. Anchors: Metallic and ceramic anchors suitable can be selected as per the detailed procedure available on request.
4. Equipment specification / Requirement

- High Intensity mechanical paddle type mixer capable of mixing 100-250 lgs/batch preferably wesmen make VAM type mixer or similar VAM / Paddle mixer(Typically 25-30 rpm)
- Skin vibrator / Needle Vibrator, the rate of vibration should be at least 12000-1400VPM.Needle ϕ 25-60 mm depending upon thickness of lining.
- Graduated container should be used measure exact volume of water. Other tools and tackles used should be clean & contamination free.
- Use clean ice cold water 18-20°C for making.

5. Installation:

Mixing:

- Clean and wash all the equipment to be used for making (i.e mixer needle vibrator etc,) before starting mixing. do not mix more materials than can be placed within 15 minutes from th estart of water addition.
- Dry mix the entire bag for 2 minutes.
- Add 3/4th of water recommended and mix. Add remaining water in small increments till required consistency is achieved. Wet mix for 5 minutes.

Water consistency: To check if water added for mixing is coorect,make a ball with the mix and loss up 15-30 cm.

- If water added is correct, ball appears as oily looking & remains intact when caught.
- If water added is less it crumbles when caught.
- If water added is more it flattens when caught.

Refer our Test certificate and ensure that water added fails in $\pm$ 10 % recommended by us

Placement: Placement of mixed refractory Castable covers several functions

- To position and consolidate freshly mixed mass within 10 minutes of leaving the mixer
- To work in a manner which minimizes material segregation
- To fill all voids, particularly around obstruction and in corners and to remove entrapped air bubbles

Once application has started, if shall proceed without interruption until the lining of the part or section is completed. Continue vibrating until the mass has settled into place and the surface gives an appearance of oily wetness and air bubbles have stopped raising.

While removing, the vibrator should be drawn upwards very slowly through the Castable so that it does not leave any holes or channels.
Continue and repeat the above until desired thickness/volume is achieved.

- **Insulating Castable installation** – Avoid vibrating unless necessary and use tamping / Roding method to achieve consolidation
- Multi-Layer linings where insulating/dense Castable have been previously installed, it should be coated with an impermeable membrane (burn out membrane, like plastic sheet Bitumen paper, Wax paper, etc) to prevent moisture loss from the fresh Castable into insulating layer alternatively the taken back layer of castable/brick/fibre may be dampened prior to casting by lightly spraying water.
- Curing: The purpose of curing is to prevent loss of moisture from freshly cast refractory during the chemical changes associated with hydration of the calcium Aluminates binder. When mixed with water an exothermic reaction takes place that drives off water at an early stage loss of water from surface before cement is fully hydrated results in strength loss.
- To prevent this formwork should be placed in position for at least 12-15 hrs and exposed surface either lightly sprayed with water, or covered with plastic sheet if steel formwork is used try and cool by spraying water lightly on warm formwork surface.
- For Low cement/ULCC Castable Sprayed WATER should be used to cure the casting alternately cover it with polythene sheet 24 hrs from the placement.
- After moist curing, formwork can be de-shuttered carefully after about 12-15 hrs of casting ensuring mass is fully set. A further 24 hrs drying is normally allowed before the lining is fired to further increase the final strength.

Castable Mixing, Curing, Dry-out, Lining Inspection & Repair Procedure

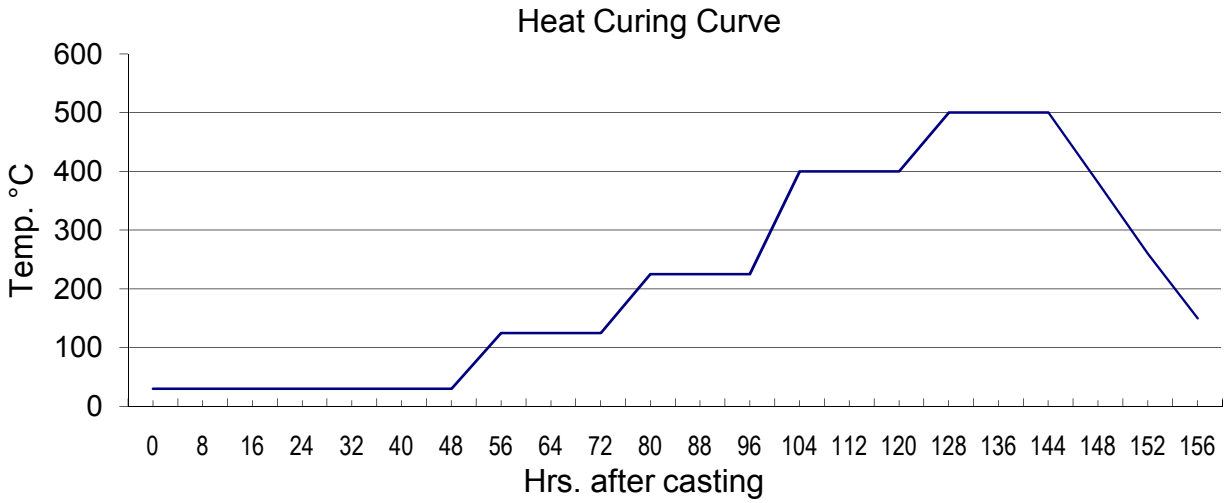
- Clean all the tools & tackles which shall be used for mixing of castable like paddle mixer, trowel, needle vibrator, buckets etc.
- Empty the content of the bag into the mixer.
- Pre determined amount of fresh, cool, & clean drinking water within manufacturer's specified range at 15-20°C should be used for wet mixing. Ice shall be used to maintain the temp. Chloride content of water used for mixing shall be within 200-ppm max.
- Dry mix for about 2 min. then add the half the qty. of water as recommended by the manufacturer after mixing for about 1-2 min. add balance water. Again mix for 2 –3 min. and discharge the material on wooden tray.
- Ball in hand test shall be done before discharging the mix to ensure proper water addition.
- This mix is now ready for casting.
- Ensure this mix shall be used for casting within 30 min.
- After casting the mix leave undisturbed for min. of 8 hrs.
- Ensure to cover the cast surface to avoid loss of water.
- Cover the surface with gunny bags moistened with water. Water shall also be sprinkled on casing plates to keep castable cool.
- Shutter can be removed after 24 hrs. of casting.
- Cure the cast surface for min. of 24 hrs. by sprinkling water/covering with moistened gunny bags.
- Leave the castable lining undisturbed for min. 24 hrs.
- Inspect the cast surface for following after curing
    - Surface cracks
        - Hair line cracks
    - Unevenness of surface
    - Blow holes

- Inspect the cast surface for following after drying
    - Surface cracks
        - Hair line cracks
        - 3 mm and more, width up to 50% of lining thickness or more 50mm depth incase of single lining.
        - Incase of dual lining 3 mm and more, width up to lining thickness of top layer or beyond the second layer.
    - Soundness of lining (sound Test)
- Repair procedure
    - Hairline cracks may be ignored if only on surface. However if crack is wider it need to be repaired.
        - To repair this crack castable, remove the castable exposing anchors and edges of the exposed castable area should be made like dovetail.

List of records to be maintained:

1. Test certificate from manufacturer
2. Shift casting report giving details of cleaning of shell, anchor pitch marking, welding of anchor, bend test, painting of shell & anchor, anchor tip protection, back-up insulation (like asbestos mill board, calcium silicate block, vacuum formed board etc.) panel size for casting, total area casted, water temperature, %water used for mixing, Time of casting, Site samples, shuttering removal details, starting of curing, completion of curing, expansion joints,
3. Record of test results of site sample
    a. Bulk Density, Cold crushing Strength.
4. Usage of materials.

- **Dry out**: Dry out shall be done in accordance with recommendations as given below.



Note: Steam shall not be used for the purpose of dry out.

- Cure at ambient temp. for 48 Hrs. Min.
- Raise the temp. to 125°C @ 20°C/Hr. Hold at 125°C for Min 24 hrs.
- Raise the temp. to 225°C @ 25°C/Hr. Hold at 225°C for 24 hrs.
- Raise the temp. to 400°C @ 20°C/Hr. Hold at 400°C for 24 hrs.
- Raise the temp. to 500°C @ 20°C/Hr. Hold at 500°C for 24 hrs.
- Cool from 500°C to 150 @ 30 - 35°C/Hr.
- Below 150°C cool naturally with sealing of all openings.

Castable Lining Inspection & Repair Procedure

- . Inspect the cast surface for following after curing for
- **Visual Inspection for**
  - Surface cracks
    - Hair line cracks
  - Unevenness of surface
  - Blow holes
  - Loose structure
  - Surface cracks to be classified as follows :
    - Hair line cracks
    - 3 mm and more, width up to 50% of lining thickness or more 50mm depth incase of single lining.
    - Incase of dual lining 3 mm and more, width up to lining thickness of top layer or beyond the second layer.
- **Hammer Test (Sound Test)**
  - Soundness of lining (sound Test)
- Repair procedure
  - Hairline cracks and cracks upto 2mm may be ignored if functionally it does not affect the operation. However if crack is wider more than 3mm it needs to be repaired.
    - To repair this crack castable, remove the castable to such an extent that exposes anchors and edges of the exposed castable area should be made like dovetail.
    - Use the wire brush to clean the area that needs to be repaired.
    - Anchors must show on either side of the area that needs to be repaired.
    - Also the Castable joints must be cleaned, free from loose particles.
    - Where the area is less than 500mmx500mm or less,mix the sane Castable as was removed to a stiff consistency and pack the material in.If the size is more than 500mmx500mm,reinstall the Castable in the same way in which it was originally installed.
    - Also before installing Castable refractory,use clean water to wet the already installed lining in contact with the repair refractory.

GUNITE APPLICATION PROCEDURE

1. **Storage:** Store Castable under covered shed, on pallets stack 15 high Max

2. Surface Preparation :In all applications of gunite, surfaces should be thoroughly cleaned and wet down prior to start-up. This is done by turning on the compressed air, opening the water valve at the nozzle and spraying the surface. When continuing on from the previous days work, joints, surrounding areas and steel or mesh must be wet down as well. If the surface to be gunited is heavily coated with foreign material or has ingrained dirt, it may be necessary to sand blast or wet sand blast the surface using the guniting machine with a specially designed nozzle for the purpose.

3.Anchors: Metallic and ceramic anchors suitable can be selected as per the detailed procedure available on request.

4.Equipment specification / Requirement

- High Intensity mechanical paddle type mixer capable of mixing 100-250 kgs/batch preferably wesmen make VAM type mixer or similar VAM / Paddle mixer For **Pre dampening of the MIX**
- **Gunning Equipment with Double Cone arrangement**
- **Compressed air 300 CFM capacity and 100psi pressure**
- **Water Tank and pump**

Use clean water preferably 18-20°C for gunniting

5.Gunning procdure:

Predampened Mix is fed into the Gunning equipment which is pneumatically conveyed by Hose to nozzle where water mixing is done and adjusted by Gunman(also Called Nozzleman)

When guniting in confined spaces, care must be taken not to contaminate the surrounding areas with overspray travelling ahead at the point of application. To prevent this from occurring, the nozzleman should immediately apply a light coating of gunite over the surface which will then act as a bonding agent absorbing any small amount of overspray. More than one pass with the nozzle, applying a thin layer of material each time prevents accumulating sand on the wet surface. Nozzle distance depends on the type of application and will vary with air pressure, amount of material being placed, and the skill of the nozzleman. On a typical gunite job, nozzle distance may be from 1 to 1.5 metres from the working surface. However, when guniting thicker sections, cover steel or mesh, the nozzle distance at times may be as short as 0.75 metres from the working area.

Securing a proper bond is primarily a mechanical function, but there is some chemical action between the concrete and gunite as well. On a clean surface the gunite on impact forms a dense, cohesive mass having zero slump and penetrating every irregularity and remains in place held by reinforcement. At all times reinforcing should be in accordance with the site engineer's instructions. The combined efforts of cohesion, capillary action and force between the existing surface and the hardening cement in the freshly applied gunite surface forms an effective and lasting bond.

The nozzleman, after wetting down the immediate area to be gunited with a blast of compressed air and water, reduces the flow of water at the nozzle, while compressed air is maintained, signals for material. As the material arrives at the nozzle, water flow is then adjusted for proper hydration so that the gunite arrives at that work it just glissens. Insufficient water results in a sandy, dry- appearing application and increased rebound. Too much water, and the material will slough and slide off. "Rebound" consists of partially coated sand or aggregate particles that do not adhere to the work The amount of rebound will vary with the distance of the nozzle from the surface and the velocity and the angle at which the nozzle is held. Normally the nozzle stream is directed at right angles to the work surface.

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6.FINISH

The initial layer or layers of gunite should not be finished or screed in any way until an initial "set" has taken place. The material may be lightly screeded with the side of a trowel or a screed after an initial set. It is not recommended that gunite be floated or trowelled while in the process of setting up. With the limited amount of water contained in the material, any trowelling on the surface will pun moisture to the surface, thereby weakening the entire coating. If a smooth finish is desired, a final flash coat of 4mm thickness is applied over the previously set up and dampened material and this final coating is trowelled or floated to the desired smoothness.

7.CURING of Guniting

As in concrete, gunite shrinks as it dries. However, because of its low initial moisture content, properly applied gunite should never indicate major shrink cracks. Particularly in thin sections, as the moisture evaporates, slight surface cracks can occur unless provision has been made for early curing. The most universal method of curing is the application of water to the freshly finished surface either by fine spray, fogging, application of wet burlap or a spray coat of membrane curing compound. This treatment is important in inhibiting rapid loss of moisture and improves the ultimate strength and prevents surface cracking and crazing because of an increased shrink factor. Proper curing is very important to the finished product regardless of thickness.