



Monolithic Refractories Installation

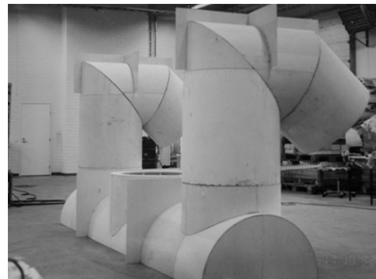
Venue – Holiday Inn Rotherham
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Dave Pickard



Form-work

- Some form-work can require skilled fabrication/construction



Monolithic Refractory Installation

- Preparation
 - Quantity
 - Form-work
 - Installation Method
 - Access
 - Time Available
 - Materials Selection
 - 4 Main Types
 - Dry Vibratable
 - Ramming
 - Gunning
 - Castable
 - Vibro-cast
 - Pumpable
 - Shotcrete
- Consideration to all these aspects will lead to a repair methodology
- Typically, the best solution may be to Cast the new lining with a high duty, dense castable. But there may not be enough time! Or, it may be too expensive!



Installation Method

- Access
 - Most installations are done manually.
 - However, if access to the repair area is restricted, due to temperature or toxic gasses, then robotic application maybe necessary

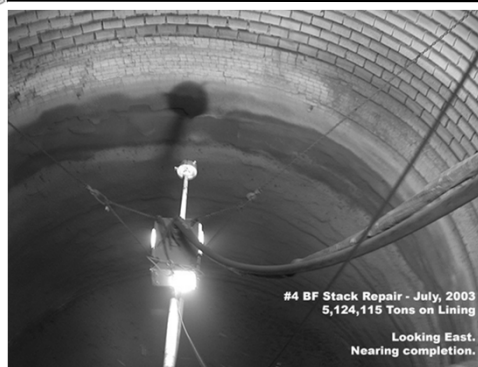


Preparation

- Quantity
 - Volume required x Density of material
 - However, with some monolithic materials an allowance has to be made for waste
- Form-work
 - Can be simple shuttering
 - Can be complicated



Robotic Repair of BF Stack



#4 BF Stack Repair - July, 2003
5,124,115 Tons on Lining
Looking East.
Nearing completion.



Installation Method

• Time

- Take repairing a steel ladle with castable as an example

Case 1 new lining	Case 2 veneer repair	Case 3 Shotcrete (robotic)
• Cooling 12hr	• Cooling 12hr	• Cooling 4 hr
• Cleaning 4 hr	• Cleaning 8 hr	• Cleaning 8 hr
• Set former 6 hr	• Set former 6 hr	• Set former 0 hr
• Cast Lining 2 hr	• Cast Lining 2 hr	• Cast Lining 2 hr
• Cure Lining 24hr	• Cure Lining 24hr	• Cure Lining 0 hr
• Remove former 4 hr	• Remove former 4 hr	• Remove former 0 hr
• Dry 38hr	• Dry 19hr	• Dry 16hr
• Total 90hr	• Total 75hr	• Total 30hr

Although significant time can be saved depending on the repair method the subsequent campaign life may be reduced



Material Types - Ramming

• Ramming

- Supplied as a moist granular or plastic (mouldable) material
- Products can be simply clay bonded or may be chemically bonded with phosphoric acid or sodium silicate



Material Types – Dry Vibratable

• Dry Vibratable

- Dry aggregates with a specific particle size distribution which compact under vibration
- Because the product is dry no drying time is required
- Usually have a low temperature bond and sinter at high temperature



Ramming



Hand-held pneumatic rammer is used to consolidate the refractory



Dry-vibratable Refractory Installation



Electric Hearth Furnace Hearth:
Use of dry vibratable basic material to construct or repair the hearth.
Material is poured from a big bag, distributed manually into place and then consolidated using vibration skeds (think of installing block paving!)



Ramming

- Is a traditional installation method
- Is used for relatively small installation quantities
 - Around tundish nozzles
 - Small patch repairs
 - Sloping sections of re-heat furnace roof
- Because of vibration white finger, HSE limit use of rammers to 2minutes in one 8hr shift



Material Types - Gunning

- Gunning
 - Generally supplied as a dry granular material
 - Traditionally clay bonded but more sophisticated formulations exist which use special chemical bonding agents
 - Material is blown using a high volume of compressed air from a feed machine to an application nozzle
 - At the nozzle, high pressure water is introduced which mixes with the gunning to form a sticky consistency
 - The material is densified due to high impact velocity



Gunning

- Compositions vary from simple alumino-silicate materials to high duty pure alumina materials
- Equipment is portable and easy to set up
- Installation rates up to 3 tonnes per hour
- Can get up to 20% rebound loss
- Water addition depends on the skill of the nozzle man and can lead to a variation in properties



Gunning

- The Gun



Material Types - Castables

- Castables
 - Predominantly cement bonded although sol-gel and resin bonded variations exist
 - Cement bonded are either regarded as
 - Conventional $\approx 20\%$ cement
 - Low Cement $\approx 5\%$
 - Ultra Low Cement $<2\%$
 - Formulated using precise particle size distribution and specialised additives to promote flow at low water contents
 - Consolidated using vibration



Gunning

- The Nozzle



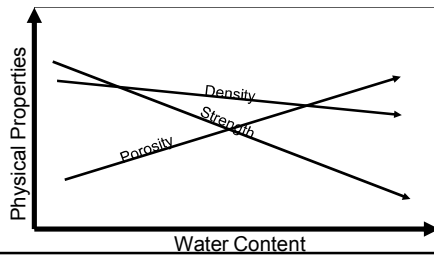
Castables - Installation

- Castables
 - Mixing
 - Pouring / Pumping / Shotcrete
 - Drying



Castables - Mixing

- Usually require high intensity, high shear mixer to achieve a fluid consistency at the correct water addition



Pump Casting



Pump Casting Major Installation

High capacity mixer and pump



Castables - Shotcrete

- Similar application method to gunning but with much less rebound (<5%)
- Castable is mixed with the correct amount of water at the mixer
- Castable is pumped to the application nozzle
- Compressed air is used to project the castable from the nozzle
- A chemical activator is introduced at the nozzle to destroy the deflocculating system thus allowing the castable to stay in place



Pump Casting

Delivery pipes to
Repair area
Pumps are
capable of moving
60t of castable
per hour
Installation speed
is often limited by
mixing speed



Shotcrete Pump





Shotcrete Application



Institute Of Refractories Engineers

Monolithic Refractories Installation

Thank you for your attention

Any questions?

Dave Pickard



Castables - Drying

- To bond the castable together the cement reacts with water to form a bonding phase comprising of alumina and calcium-aluminate hydrates.
- Some of these hydrates are stable up to 450°C
- Dense castables must therefore undergo a precise drying schedule to prevent the formation of super heated steam which can cause the lining to explode
- Plastic fibre additions are often made which melt at low temperature and leave a path for the water/steam to escape



Castables - Drying

- Typical Drying curve for a ULC castable – 500mm lining thickness

