Institute Of Refractories Engineers

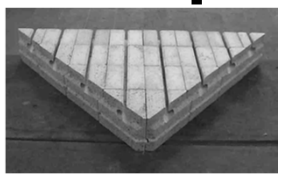
Bricks and Shapes

Andy Brewster

Formed refractory shapes

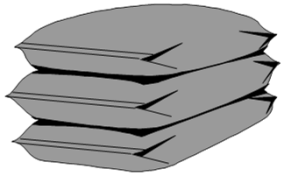
Pressed/Formed Bricks

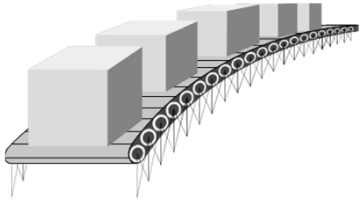
- high temperature fired Dense
- high temperature fired Insulating
- low temperature cured
- precast
- chemically bonded
- resin bonded



Monolithics

- mortars
- castables
- mouldables
- rammables
- plastics
- dry vibratables





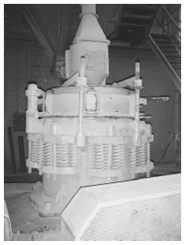
Bonding systems

- Fired
  - Ceramic Bond
  - Firing Temperature typically >1200°C
  - Usually no changes during heating up.
- Unfired
  - Chemical Bond or Carbon Bond
  - Heat treatment typically <600°C
  - Changes in properties on first heating
- Pre-cast and Pre-rammed
  - Complex Shapes Possible
  - Controlled Dry-out
  - Optimum Casting Conditions

Unfired Products

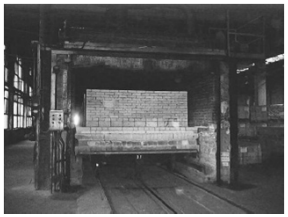
- Phosphate bonded products undergo further thermal modifications in service. These can add advantages such as permanent expansion or resistance to thermal stress on initial heat-up
- Resin bonding is only suitable where long term exposure to oxidising conditions is not present. These product rely on keeping the carbon in the system for end performance

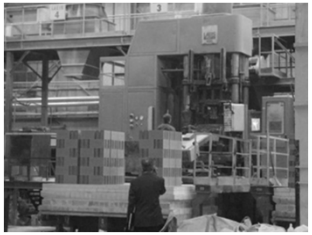
Brick Production

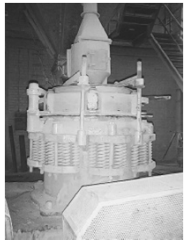
Process raw material → **Dry and Crush** → **Screen and Recycle** → **Batch to formulation** → **Form (Press/Ram)** → **Dry/Cure** → **Dry & Fire** → **Finish+Inspect +Pack**







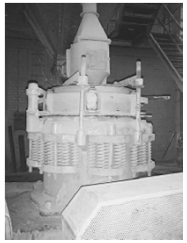
Brick Production

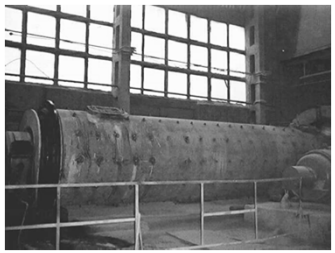


Process raw material → **Dry and Crush** → **Screen and Recycle**

Raw materials can be bought ex quarry or in processed form.
They are purchased to tight specifications, often on long term supply contracts, from established and approved suppliers.
Security of supply is an important consideration.
Test certificates are required and quality verification tests are performed on the received materials to assure quality.
Visual inspection is also necessary to confirm that the material has not been contaminated during transit.

Brick Production



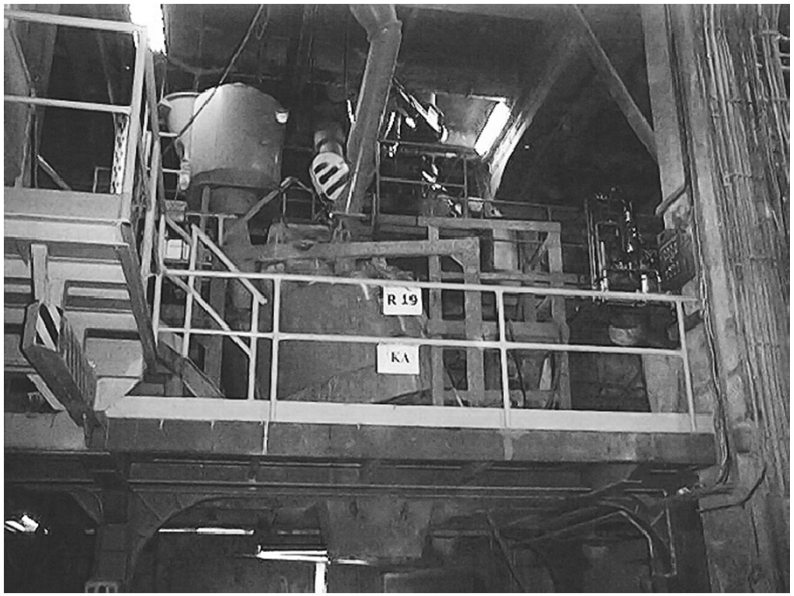


Dry and Crush → **Screen and Recycle** → **Ball Mill** → **Batch to formulation**

Raw materials are processed by drying, crushing, screening and milling to produce a wide range of size fractions from millimetre to micron sizes.
Air swept ball mills produce the very fine flour grades.
High purity materials are pre-processed and pre-blends may be purchased.

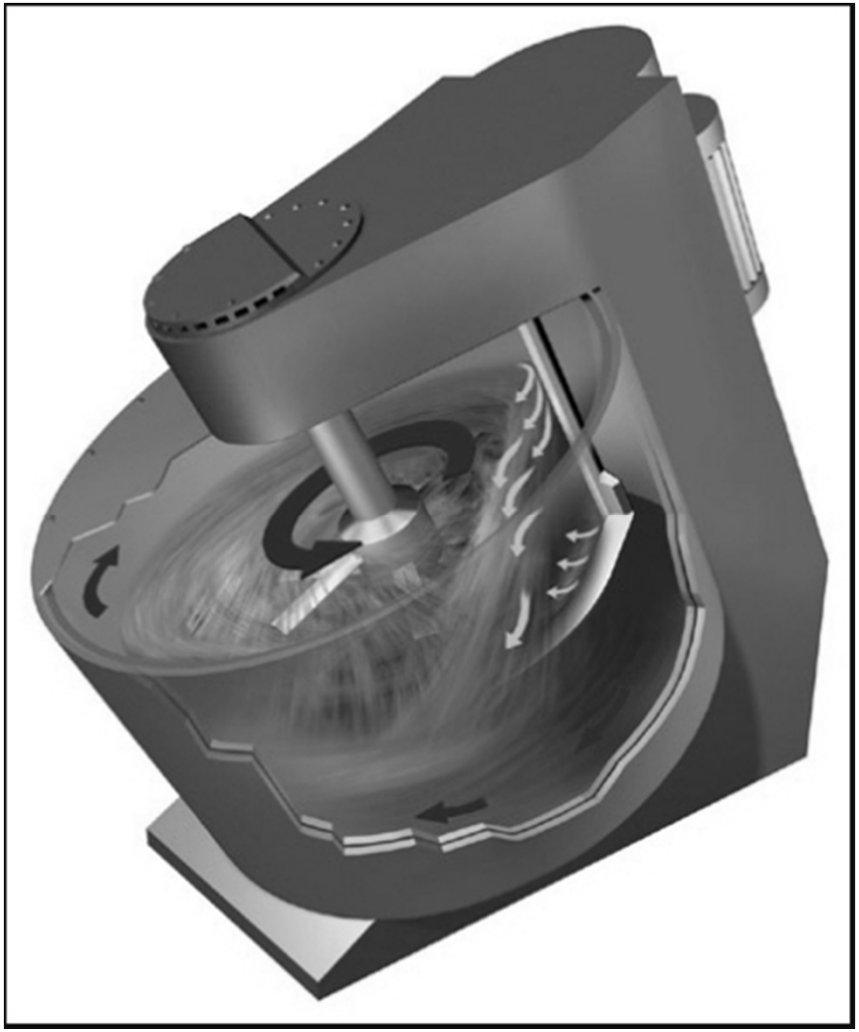
Batching

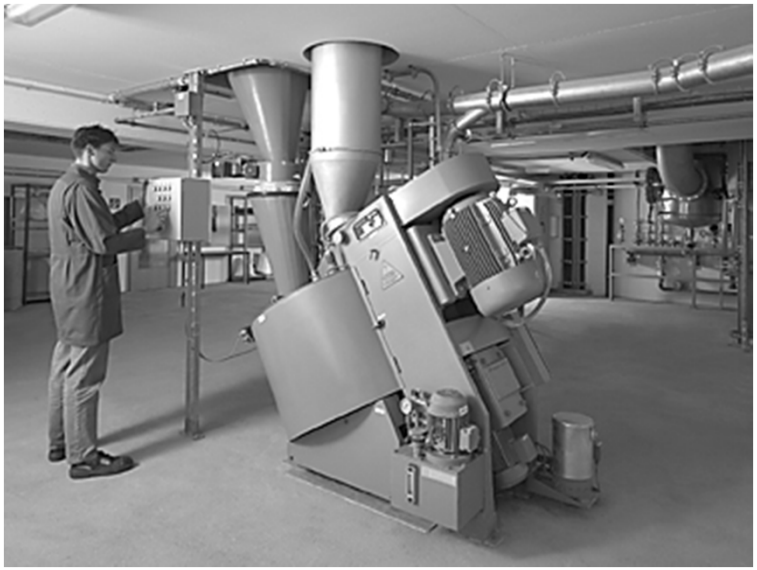
Mixing



Raw materials are combined to tried and tested recipes.
Ingredients, both solid and liquid, are added in controlled sequence and controlled proportions.
Ingredients are added which give ‘green’ strength - these provide some strength to the brick after drying.
Ingredients are designed to react during the curing/firing process to give the desired physical and hot strength properties to the fired product.
Mixing time is important. Mixes are approved before further processing.

Mixing



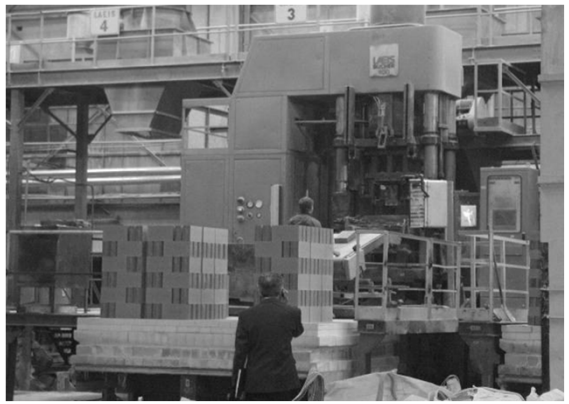


Eirich Mixer

Mischprinzip.exe

Resin bonded brick batch

Pressing



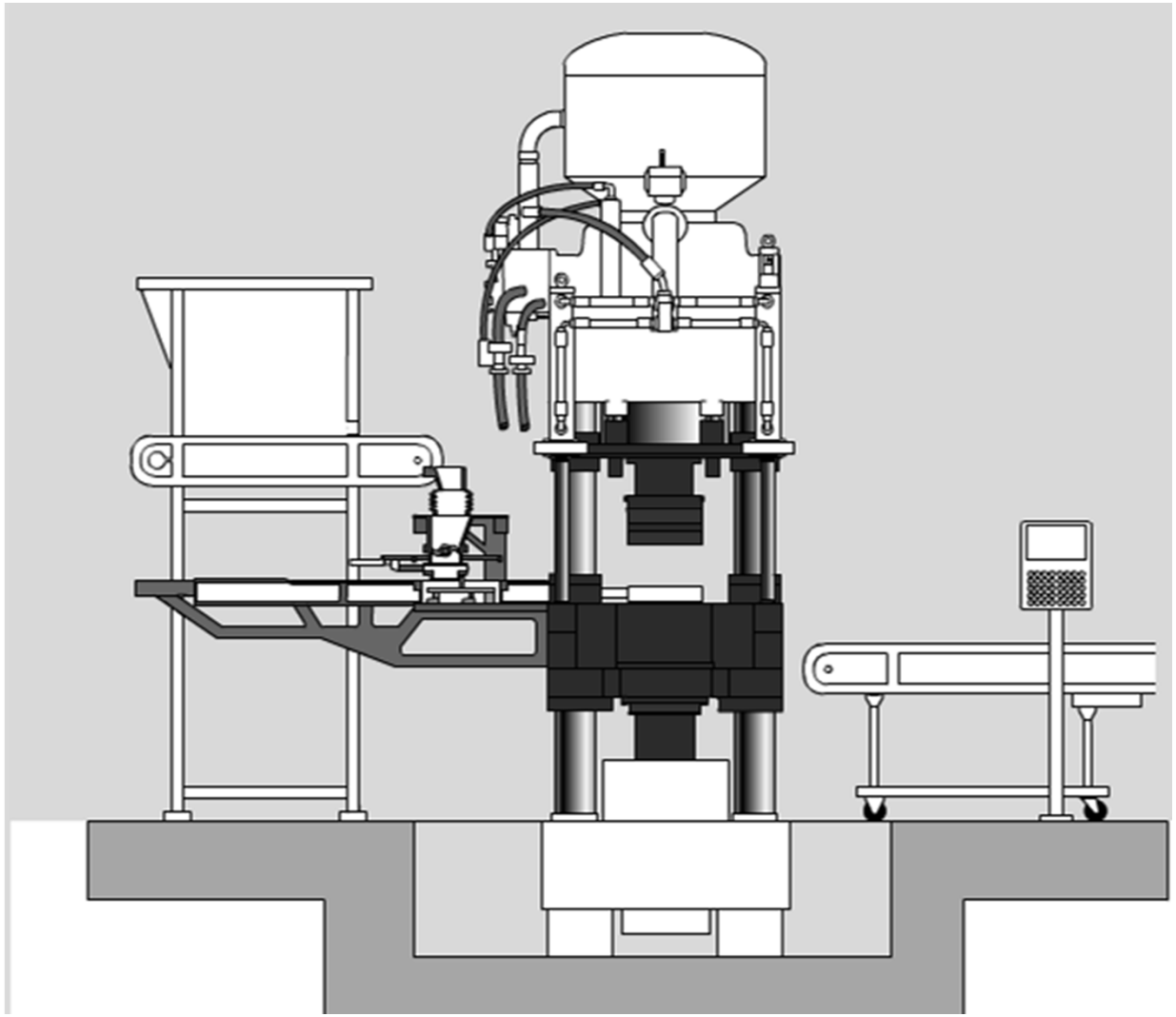
Most bricks are machine pressed.

Presses can be automated hydraulic, manual hydraulic, mechanical, impact, vibro or friction types. The presses operate over a wide range of forming pressures, making bricks from one to four at a time, frequently with robotic pick-up. Very sophisticated control systems can be applied to adjust and maintain pressed brick dimensions.

Moulds can be of hardened steel or tungsten carbide

Pressed bricks are set onto drier cars or kiln cars.

Hydraulic Press



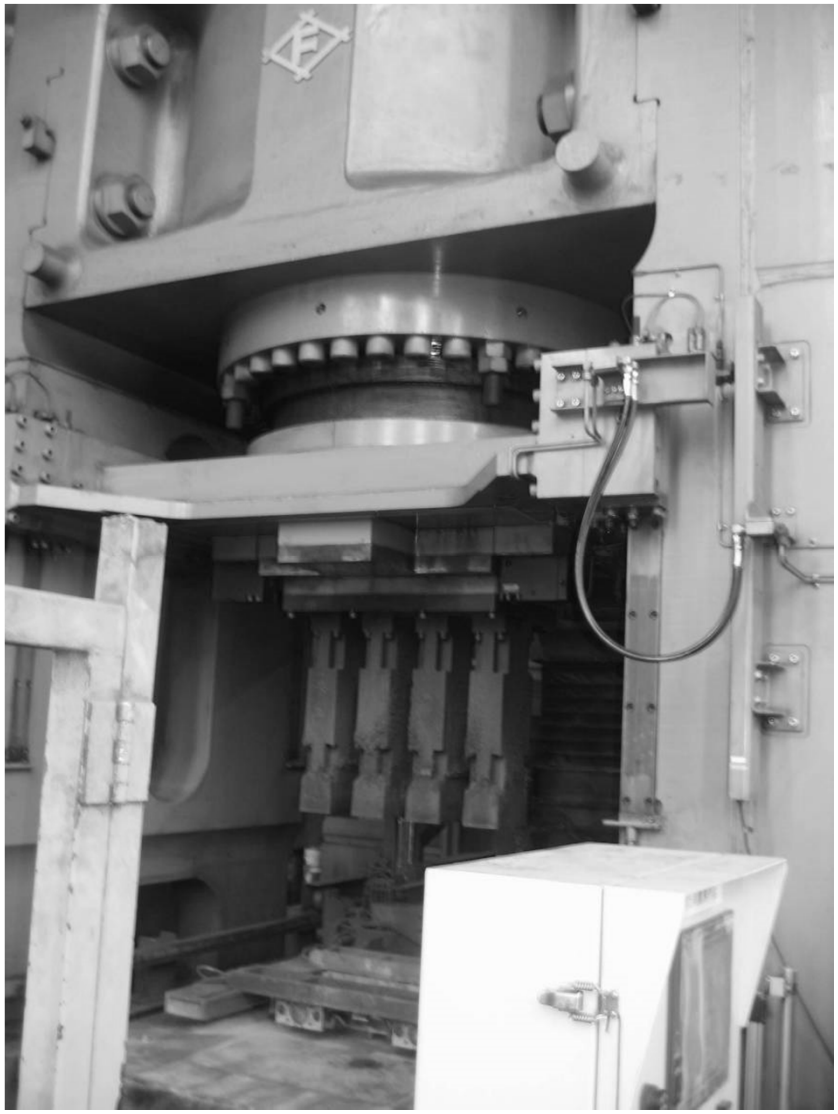
Laeis Pressing Action

hpfIII.exe

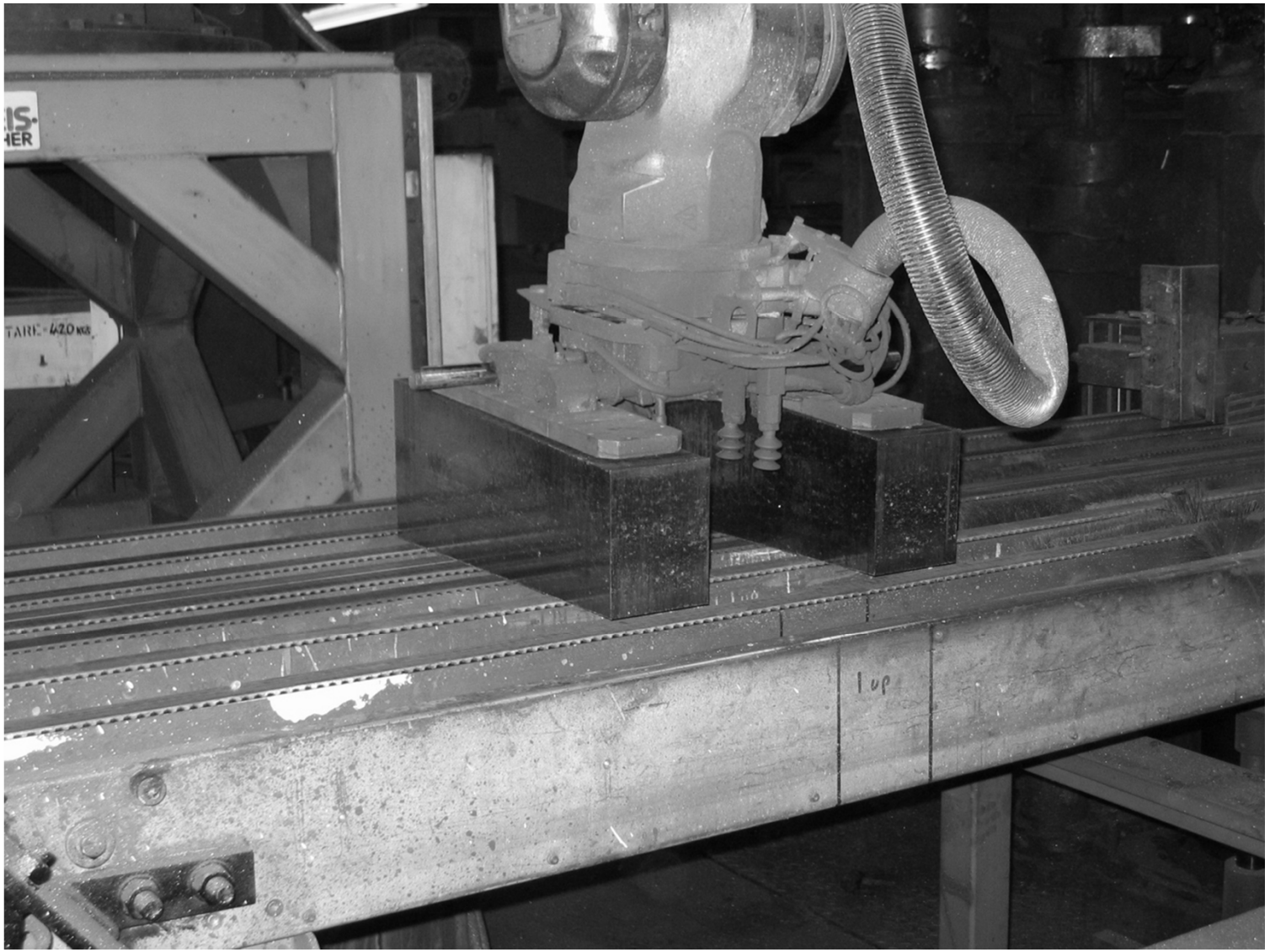
Laeis Co-pressing

2K_FF_Produkte.exe

Hydraulic Press

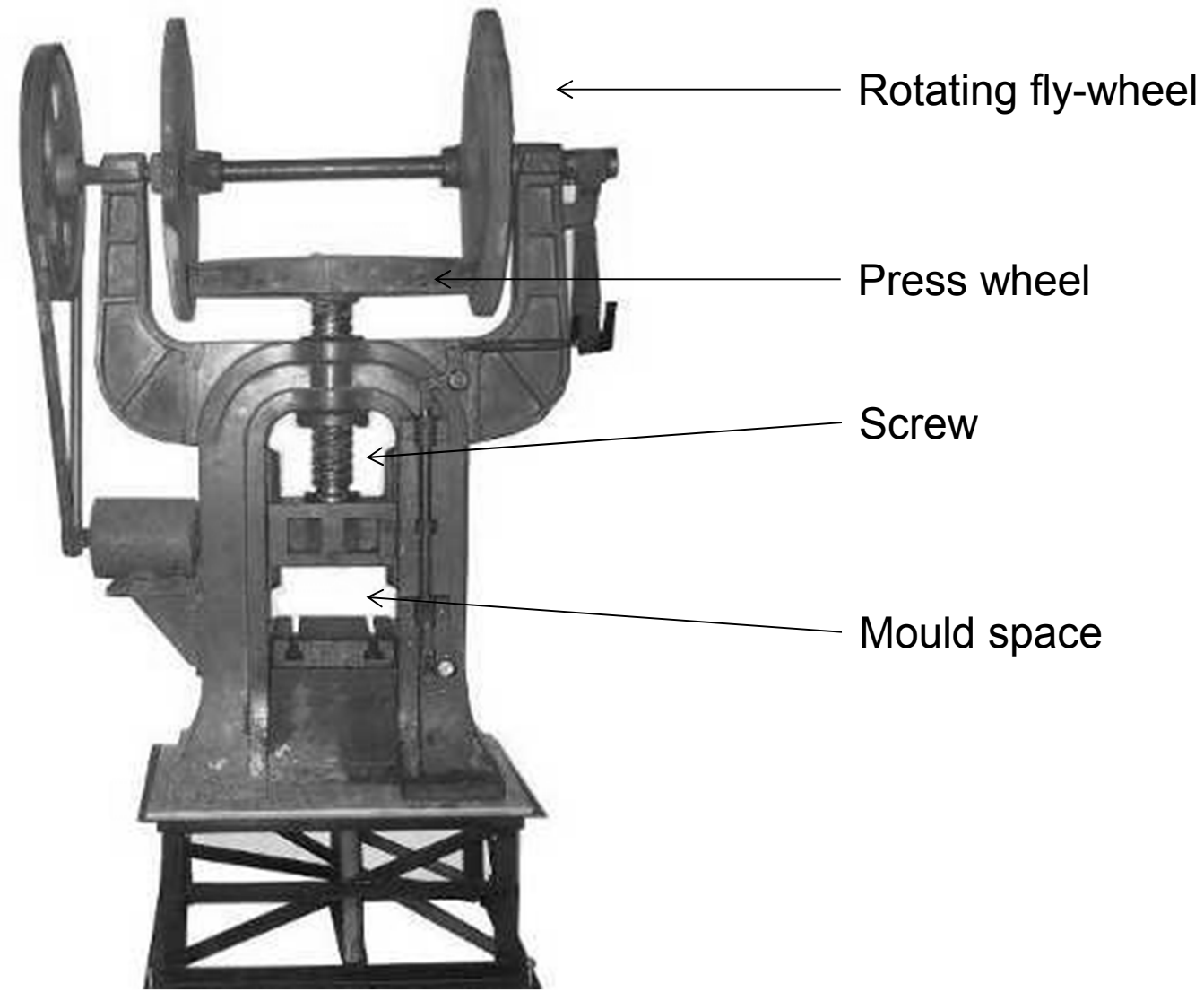


Press Robotics

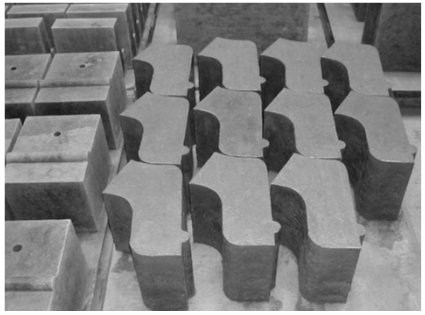


Friction or Screw Press

Friction Press



Hand-making



Some bricks are not able to be machine pressed. This is most commonly because of shape complexity but low quantity items may follow this route to avoid the high cost of press moulds.

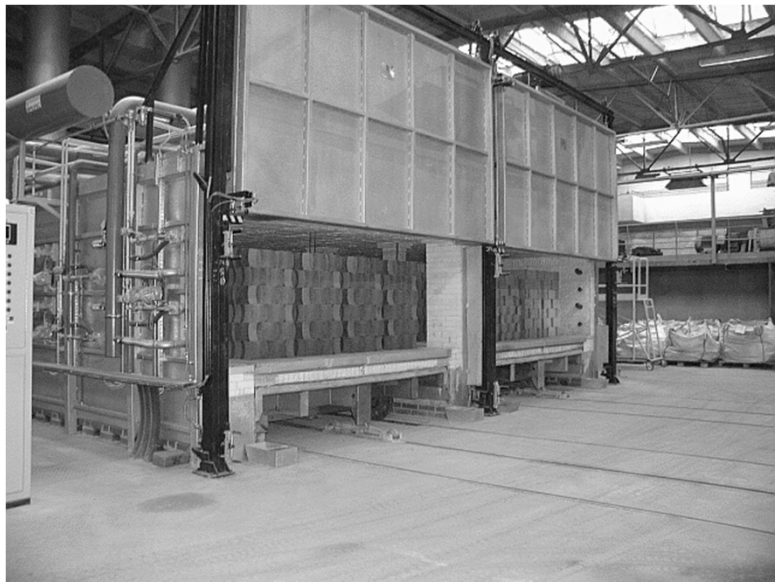
Pneumatic rammers are used on mixes formulated for hand forming.

The technique of hand moulding is an acquired skill and there are procedures to be followed to ensure a high quality product.

Controlled drying is applied to bulky shapes.

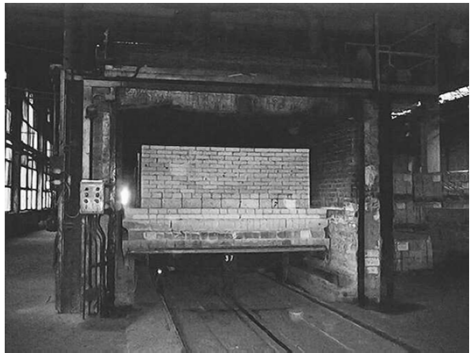
It is also possible to cast and fire special shapes.

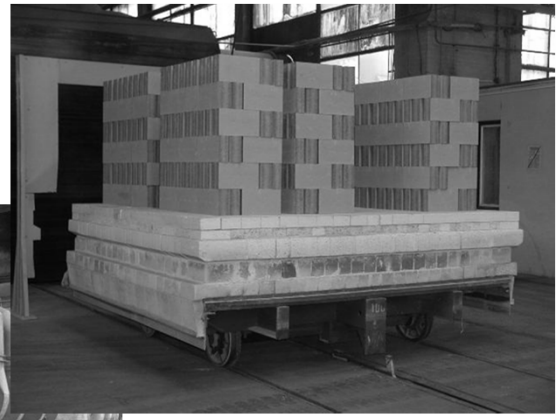
Drying/Curing/Heat Treatment



Drying is the first operation in the tempering process and is critical.
In some cases the drying process is undertaken in the entry part of the tunnel kiln where low temperatures and humidity can be controlled.
Bricks are dried according to their shape and size to avoid undue stresses which can generate or develop faults in the subsequent firing process.
Batch dryers are used for chemically bonded or resin bonded bricks and this completes the production operation for these brick qualities.

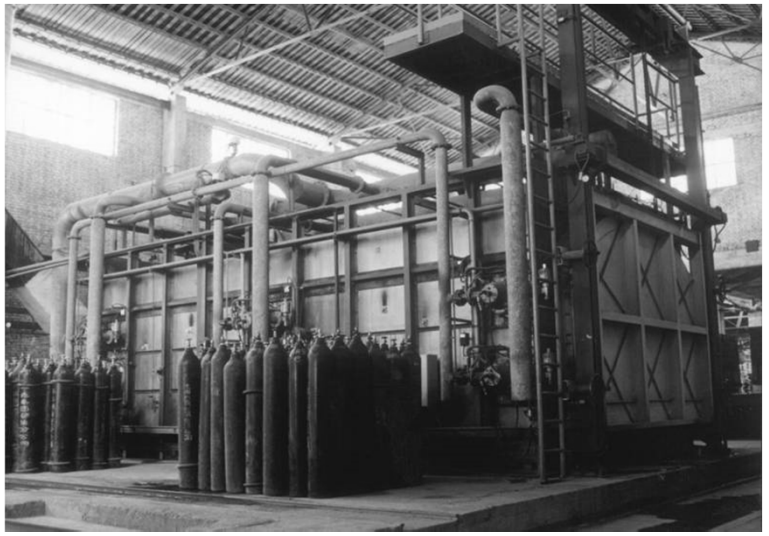
Firing

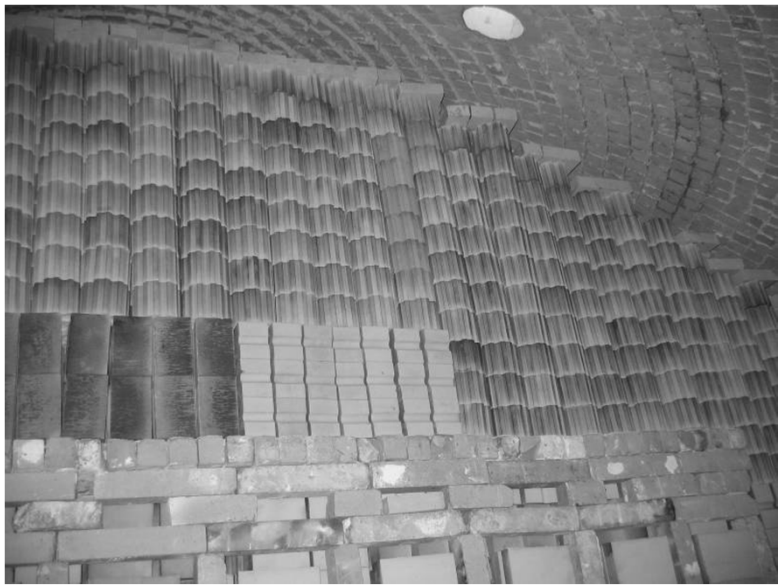




Firing is the main operation in the tempering process.
Bricks are fired in tunnel or batch kilns to controlled rates, temperatures and atmospheres. Often the first part of the kiln is the “drier”.
Typically the temperatures range from 1200°C (for firebrick) to 1700°C for high alumina and magnesite bricks.
Residence time can be 6-15 days, even longer for silica bricks, with a total firing time, inclusive of the important controlled cooling period, of 7 - 28 days.
Shape and size dictate the brick position and the setting density.

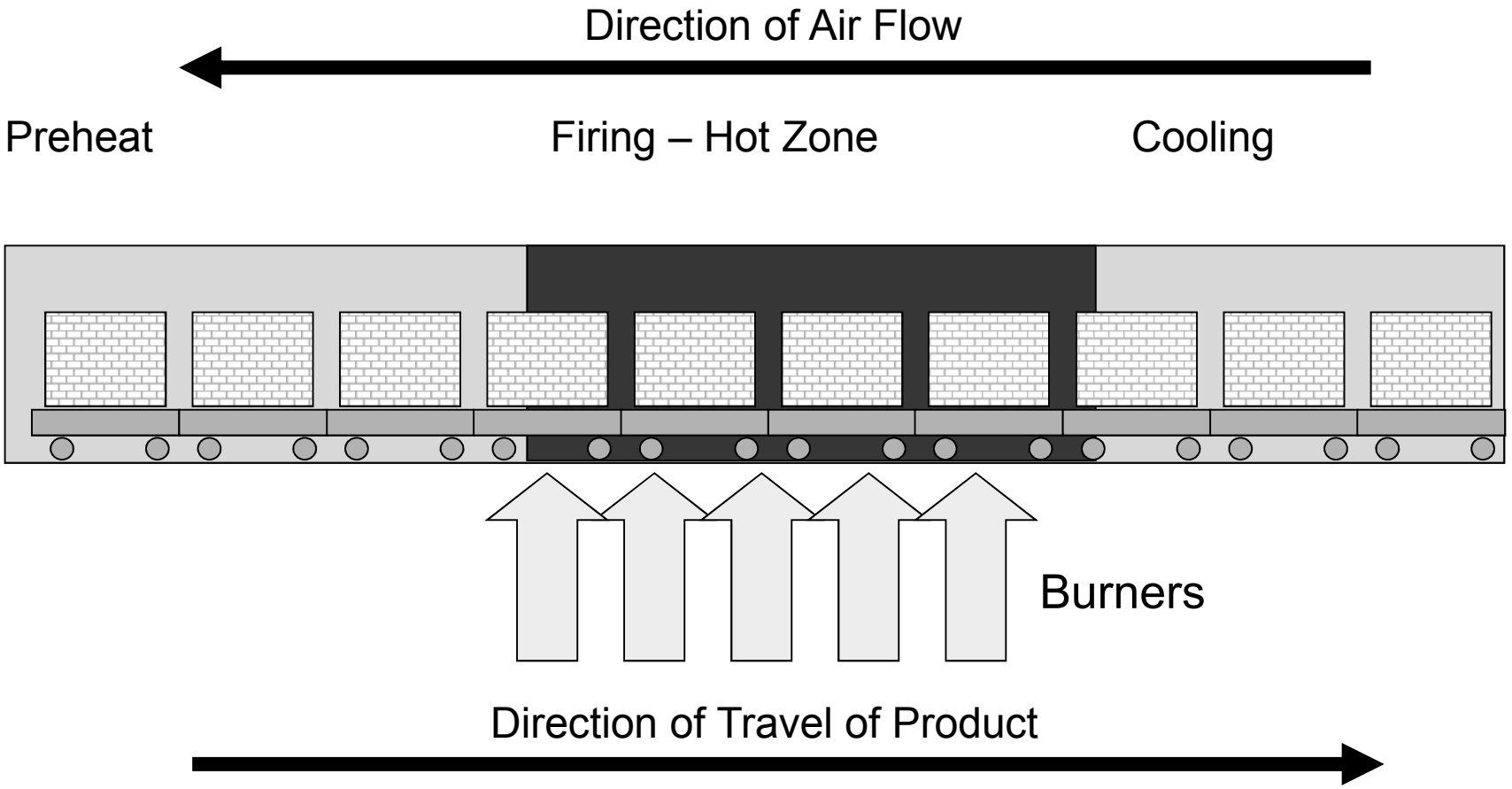
Batch Kilns





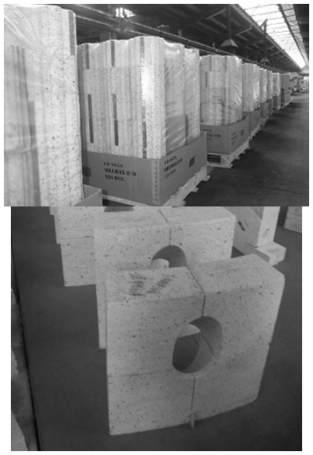
Tunnel Kiln

Tunnel Kiln


Direction of Air Flow
Preheat
Firing – Hot Zone
Cooling
Burners
Direction of Travel of Product

Tunnel kiln – Ceram Animation

Inspection and pre-assembly



The finished product is not yet finished.

Some bricks will go on to be drilled or cut into derivatives.

Some bricks will go for size banding.

Some bricks will be pre-assembled where the overall assembled dimensions can be verified.

All bricks require inspection for size and attributes and samples must be selected to go the laboratory to verify physical and chemical properties.

Testing

Control Properties

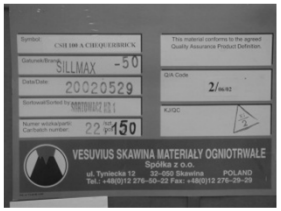
- **Apparent Porosity**
- **Bulk Density**
- **Cold Crushing Strength**

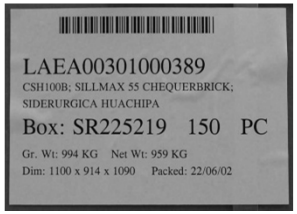
Chemical Analysis

Supplementary Physical Properties

- **Creep Resistance**
- **Refractoriness under load**
- **Abrasion resistance**
- **Thermal Shock Resistance**
- **Thermal Expansion**
- **Thermal Conductivity**
- **Hot Modulus of rupture**

Marking & Packing





The final stage of the operation is the marking/labelling of the bricks and the appropriate packing for transit to the final destination.

Bricks may be individually marked or colour coded.

Pallets may have special packaging and/or labelling.

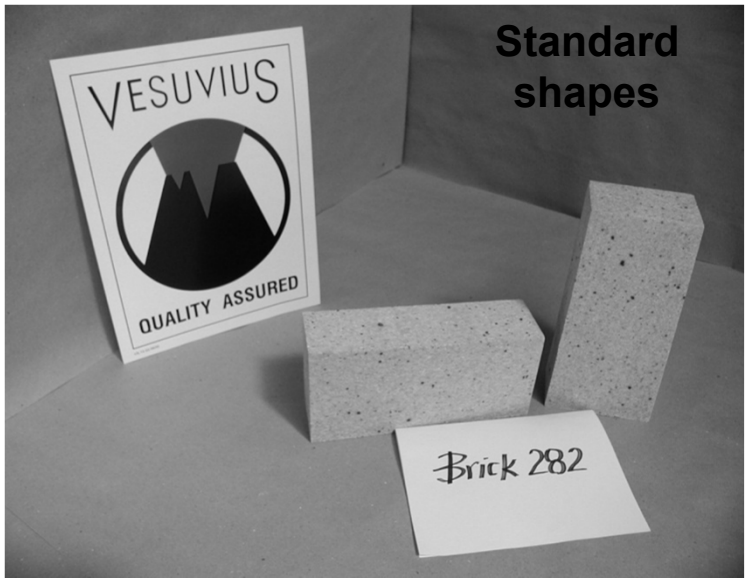
Traceability codes form part of the labelling

Installation

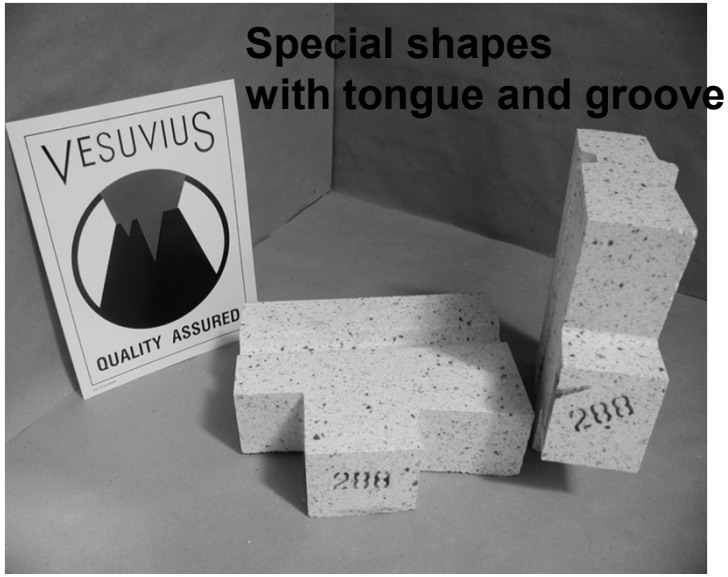
Refractory materials are selected for a particular application in consideration of their properties against the environment that they must survive.
Often there will be more than one option and more than one cost and the final decision will be made in consideration of the life expectancy and the cost effectiveness of the lining configuration.
Their may be a balance between :

- **long life but expensive**
- **cheap but short life and increased replacement/repair costs.**

Bricks come in all shapes and sizes

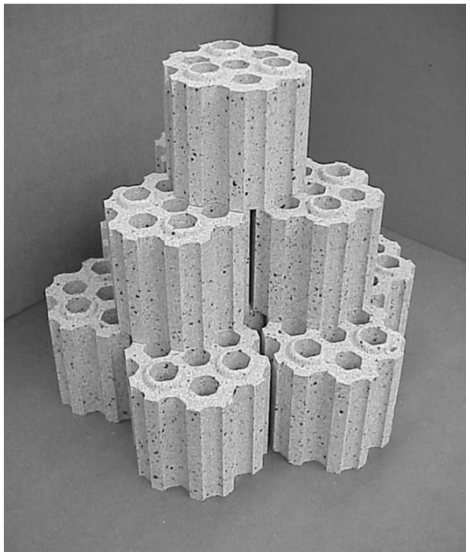


Standard shapes



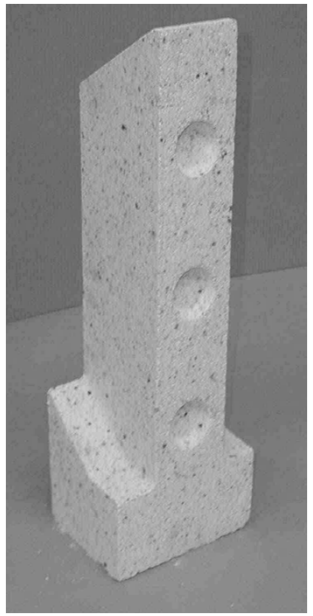
Special shapes with tongue and groove

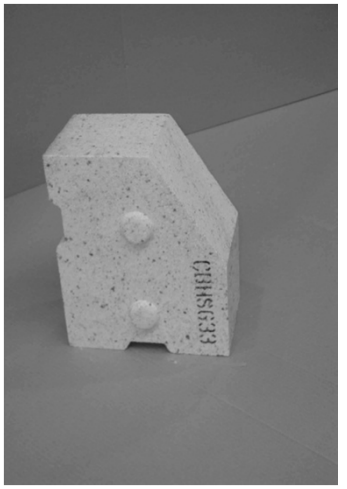
Bricks which are designed to store and release heat in regenerators.

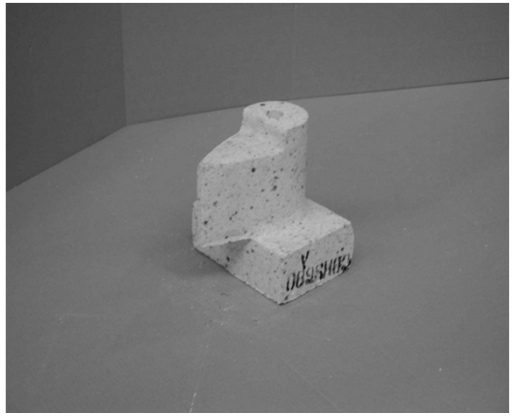


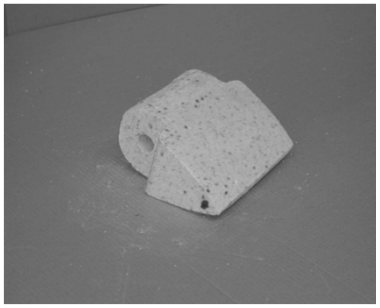
Bricks come in all shapes and sizes

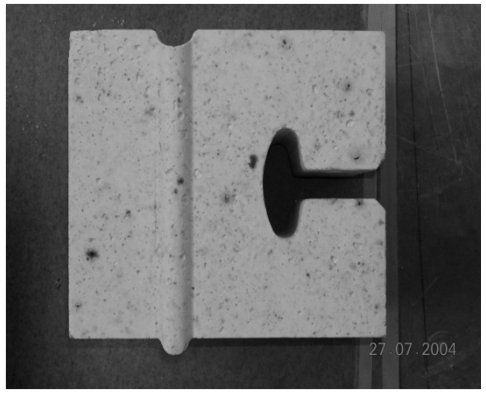
Bricks and blocks which form part of a large jigsaw puzzle.









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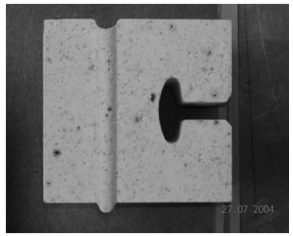
Bricks come in all shapes and sizes

Bricks and blocks where the jigsaw must be built and measured.



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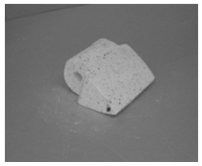
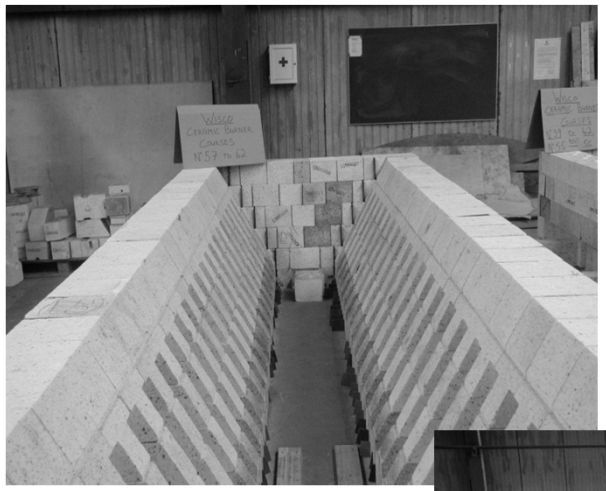
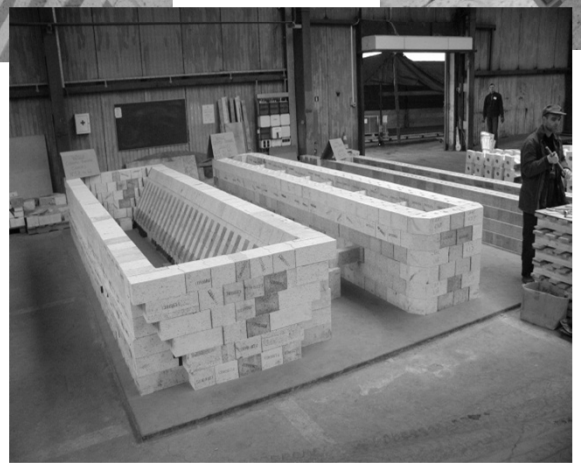




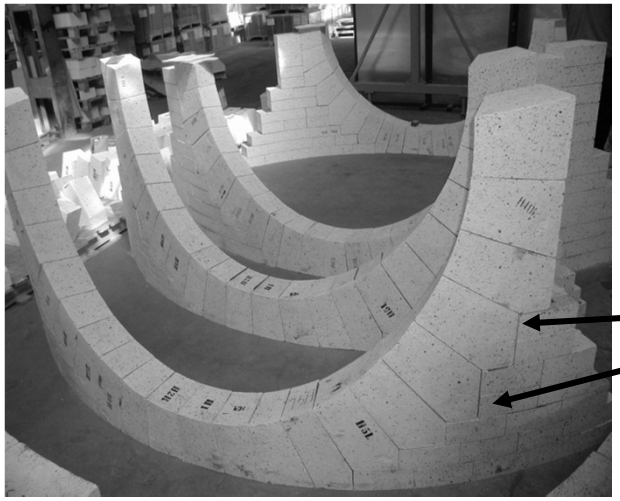
A ceramic burner for a hot blast stove designed to allow gas mixing through the burner slots



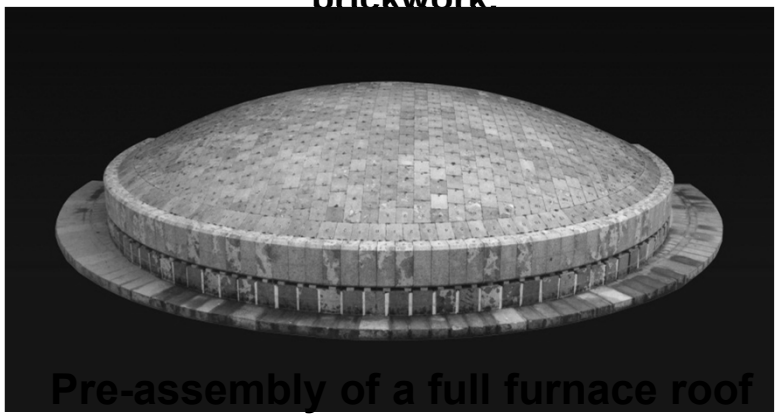
Bricks come in all shapes and sizes

Bricks and blocks where the jigsaw must be built and measured.

A precast outlet ring made to join a horizontal cylinder to a vertical cylinder

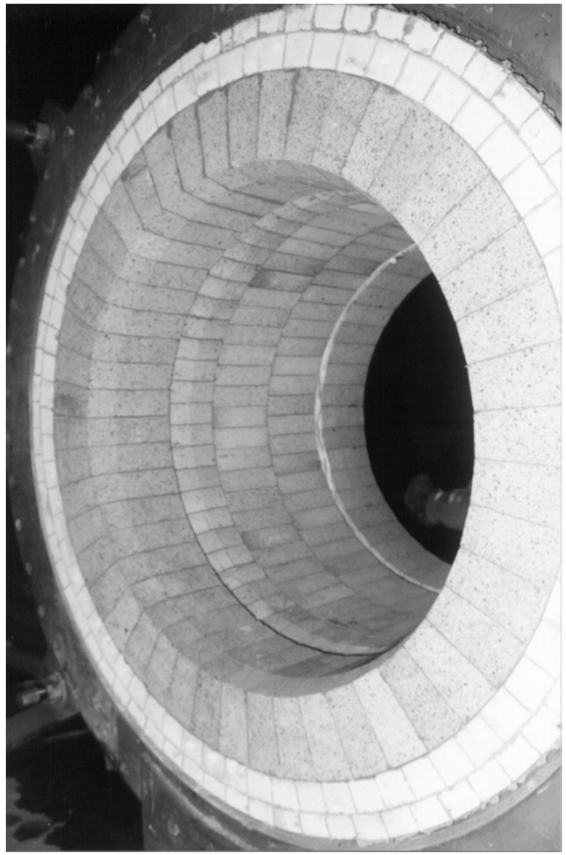


A brick outlet ring made with steps to mate with courses of standard brickwork.

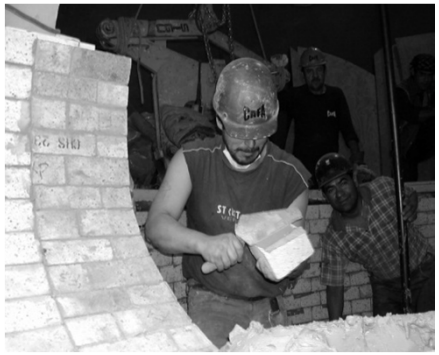


Pre-assembly of a full furnace roof

Bricks come in all shapes and sizes



The Application of Refractories



No refractory material is “perfect”.

Selection will consider an optimum balance of a combination of the physical and chemical characteristics of the particular products considered for a chosen application.

Thank You For Your Attention