Concrete Blocks

Technical Data

Building element	Wall
Size	Various sizes
Mixing ratio	1 cement : 6-8 aggregate
Cement used per m³	250 - 300kg
Resistance to earthquakes	Very good
Resistance to typhoons	Very good
Resistance to rain	Very good
Resistance to insects	Very good
Climatic suitability	All climates
Stage of experience	Widely used method
Production costs per m²	Rp. 55,000
Durability	Approx. 30 years

Short Description

Concrete block construction has gained importance and has become a valid alternative to fired clay bricks. The essential ingredients of concrete are cement, aggregate (sand, gravel) and water. Concrete blocks are produced in a large variety of shapes and sizes. They can be produced manually or with the help of machines.

Most commonly used concrete blocks are sized:

Length: 40cm (half blocks: 20cm)

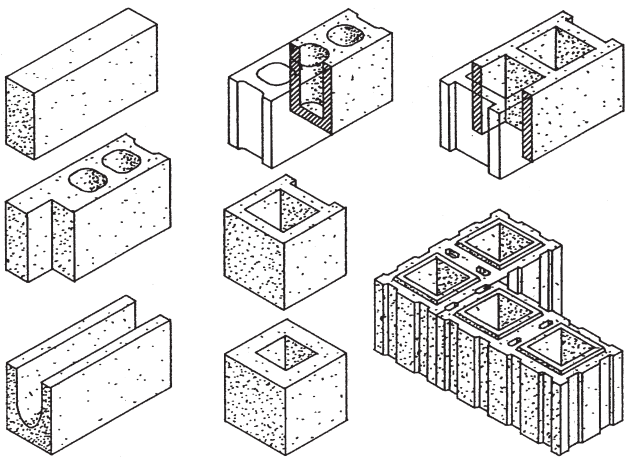
Height: 20cm

Width: 8/10/15/20cm

ArCli uses the sizes 14,5 x 29 x 14cm, 14,5 x 14,5 x 14cm (width x length x height)

Solid blocks have no cavities, or- according to US standards- have no voids amounting to not more than 25% of the gross cross-sectional area.

Hollow blocks are the most common type of concrete blocks, having one or more holes that are open at both sides. The total void area can amount to 50% of the gross cross-sectional area.



Advantages

Technical advantages

Solid blocks:

- High compressive strength, resistance to weathering, impact and abrasion
- Capability of being moulded into components of any shape and size
- Good fire resistance up to about 400°C
- Rapid construction
- Very good stability

Hollow blocks:

- Can be made larger than solid blocks
- Are lighter in weight
- Construction of walls is easy and quick
- The voids can be filled with steel bars and concrete, achieving high earthquake resistance
- The air space provides good thermal insulation
- The cavities can be used for electrical installation and plumbing

Economic advantages

- Production can be started with little capital.
- Less working time required for brick laying work with concrete blocks.
- Less mortar consumption
- Generally, production costs of concrete blocks are slightly lower than of fired bricks.

Limits of Application

- Raw materials must be locally available, of good quality and economically viable.
- Relatively large amount of cement is needed, which can be expensive and difficult to obtain.
- Special knowledge and experience of the production process is needed.

Raw Material

Cement:

- Ordinary Portland Cement
- Special cements

Aggregate:

- Sand or gravel
- Max. particle size of coarser aggregates is 10mm.
- Suitable aggregates are usually obtained from natural sources (river beds, gravel pits, volcanic deposits) or from industrial by-processes (granulated blast furnace slag, sintered fly ash).

Cement-Aggregate Ratio:

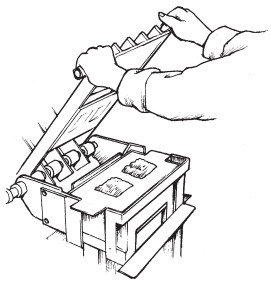
- Suitable proportion of aggregate to cement must be found by testing
- Common ratios are 1:6, 1:8
- Test the quality of blocks produced

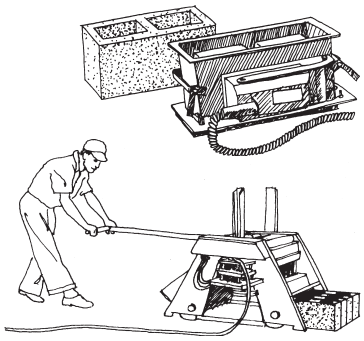
Water-Cement Ratio:

- Only drinking quality water should be used to mix the concrete.
- Recommended water-cement ratio is 0.5

Equipment

- Masonry tools
- Mixers: Pan mixers; Trough mixers
- Blockmaking machine: Hand-operated; “Egg-laying” mobile machines; fully mechanised stationary machines





Production Process

1. Batching and mixing:

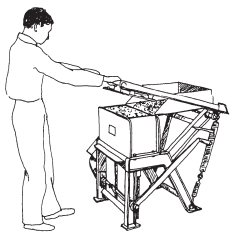
- Batch aggregates and cement by weight.
- Mix cement and aggregates using mattock, shovel or mixer until it reaches homogeneous condition.

- Add some water.

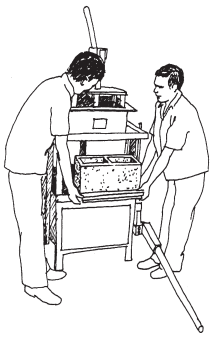
- In hot climates, the fresh mix must be shaded from the sun.

2. Moulding:

- Put the mixture into wooden or steel mould boxes or moulding machine.



- Demould blocks immediately after compaction.



3. Curing:

- Cover demoulded blocks with plastic sheets for 24hrs.
- Keep the concrete blocks moist by keeping under water in tanks or by regularly spraying with water for 7 days.

4. Storing:

- Do not expose to direct sun light; keep the blocks in a dry and covered area.
- Store for 2 weeks before usage.

Skills required

Concrete making and masonry skills

Costs for Equipment

- Manual press machine Rp. ####
- Semi automatic press machine Rp. ####
- Mould full size block Rp. ####
- Mould half size block Rp. ####
- Hand press Rp. ####

Equipment Supplier

Parry Associates, UK
www.parryassociates.com

TARA Technology and Action, India
www.devalt.org/TARA/

Appro-Techno, Belgium
www.appro-techno.com

Local suppliers (for hand operated equipment)

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Cement Floor Tile

Technical Data

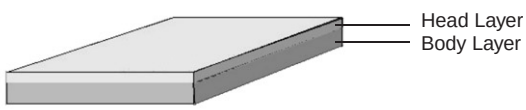
Building element	Floor
Sizes in cm	15 x 15 x 1.4cm (w x l x t) 20 x 20 x 2.0 25 x 25 x 2.4 30 x 30 x 2.6
Mixing ratio	1 cement : 5 aggregates
Cement used per m³	300 kg
Weight per m³	2.3 t
Resistance to earthquakes	-
Resistance to typhoons	-
Resistance to water	Very good
Resistance to insects	Very good
Climatic suitability	-
Stage of experience	Widely used method
Production costs per m³	Rp. 20,000
Durability	Approx. 30 years

Short Description

Cement Floor Tiles are used for the finishing of indoor floors.

They are prefabricated in diverse sizes according to the planned design and needs of the customer. They are produced either through the wet method (wet head tile) or the dry method (dry head tile). The upper layer is made from portland cement with or without coloring or additives. The bottom layer is made from a strong mixture of cement and sand (1:5).

Cement Floor Tiles are an excellent value-for-money and a good alternative to ceramic tiles



Advantages

Technical advantages

- Capability of being moulded in different sizes, shapes, and colours
- Good stability
- Easy to produce
- Easy laying
- Good indoor climate (balanced humidity; cool)
- Various attractive patterns can be formed

Economic advantages

- Production can be started with little capital
- Can be massed produced
- Equipment to produce tiles can be easily made by local workshop
- Can be an attractive business for small-scale enterprise

Limits of Application

- Raw materials must be locally available of good quality and economically viable
- Relatively large amount of cement is needed which can be expensive and difficult to obtain
- Special knowledge and experience of the production process is needed
- Can be laid only on solid under-structure

Raw Material

Cement

- Ordinary Portland Cement
- Special cements and colours

Aggregate

- Sieved stone dust
- Sand (sieved with Ø 5 mm sieve)
- Gravel
- Max. particle size of coarser aggregates is 10mm
- The ideal aggregate is of hard fine aggregate (passing an ISO 8mm sieve) by using 8 - 4 - 2 - 1 - 0,500 - 0,250 mm sieves
- Aggregate must be well cleaned

Cement – Aggregate Ratio

- A test is recommended to select the appropriate mixing of aggregate and cement
- Common ratio is 1:5

Water-Cement Ratio

- Only drinking quality water should be used to mix the concrete
- Recommended water-cement ratio is 0.4

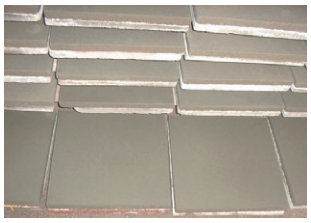
Equipment

- Mixers : Pan Mixers, Trough mixers
- Matras cement tile
- Manual moulds
- Pallet
- Masonry tools

Production Process

1. Batching and mixing

- Prepare mix for cement tile with the ratios of 1:5 (cement/ aggregate) for the body layer, and 1:0.2 (cement/ stone dust) for the head layer.
- Add some water
- In hot climates, the fresh mix must be shaded from the sun

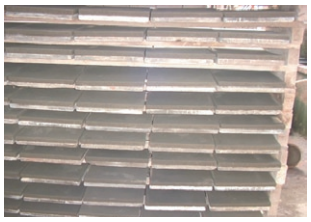


2. Moulding

- Prepare first the head layer:
- Fill the mix into prepared tile moulds up to fixed level to obtain uniform thickness of first layer
- Secondly, prepare the body layer:
- Fill the prepared mix in stages on top of the first layer until the mould is completely filled
- Demould tiles after compaction

3. Curing

- Cover demoulded tiles with plastic sheets for 24 hours
- Keep the tiles moist by keeping under water in tanks or by regularly spraying with water for 5 days.



4. Storing

- Do not expose to direct sun light, keep the tiles in a dry and covered area
- Store for 2 weeks before usage

Costs for Equipment

- Mechanized equipment sets range up to 5000 USD
- Hand operated equipment is 150 USD

Skills Required

- Concrete making and masonry skills
- Special training at ArCli is recommended

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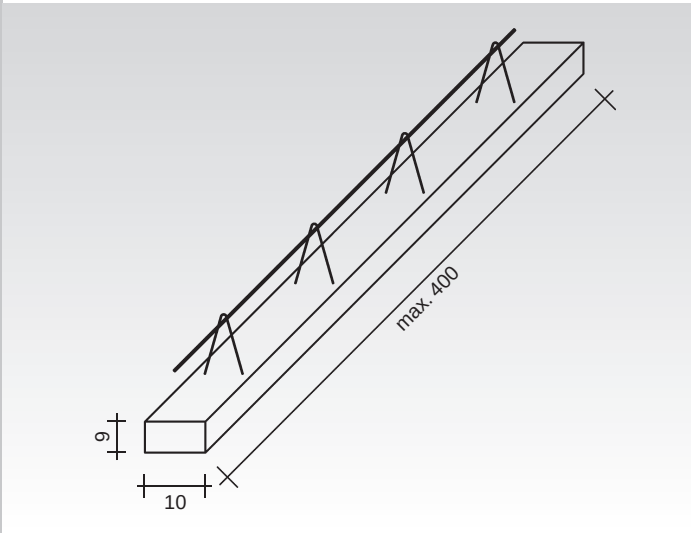
Concrete Beam



Technical Data

Building element	Beam of slab system
Mixing ratio	1 cement : 4 aggregates
Cement used per m³	460 kg
Resistance to earthquakes	Very good
Resistance to typhoons	Very good
Resistance to rain	Very good
Resistance to insects	Very good
Climatic suitability	All climates
Stage of experience	Experimental
Production costs per m²	Rp. 95,000 - 115,000 per beam
Durability	Approx. 30 years

Short Description

- Prefabricated reinforced concrete beams with integrated iron brackets
- Beams are produced for slab system
- Appropriate dimensions for the reinforcement have to be calculated according to span length and load

Size: 10 x 6 x max. length 400cm

Advantages

Technical advantages

- High structural strength
- Good fire resistance up to about 400°C
- Rapid construction

Economic advantages

- Production can be started with little capital
- Economises on building material, through longer spans
- Less wood is consumed

Limits of Application

- Span length is limited to max. 4m
- Skilled labourers and engineers required
- Engineer has to calculate reinforcement dimensions and details

Raw Material

Cement:

- Ordinary Portland Cement

Aggregate:

- Sand or gravel
- Max. particle size of coarser aggregates is 10mm
- Suitable aggregates are usually obtained from natural sources (river beds, gravel pits, volcanic deposits) or from industrial by-processes (granulated blast furnace slag, sintered fly ash)

Cement-Aggregate Ratio:

- Suitable proportion of aggregate to cement must be found by testing
- Common ratio is 1:5

Water-Cement Ratio:

- Only drinking quality water should be used to mix the concrete.
- Recommended water-cement ratio is 0.5

Steel reinforcement:

- U 24, U 39

Equipment

- Ordinary masonry equipment: spades pans, sieves, trowels, sand and cement batching boxes, balance, etc.
- Testing equipment
- Shuttering for beam moulds

Production Process

- Prepare the cement mix using cement, aggregates, and water (cement-aggregates ratio is 1:5)

- Prepare formwork by placing it on an even and neat floor with 10cm empty spaces in between
- Place the steel reinforcement and stirrups in the beam moulds
- Cast the moulds with the mortar to produce the beams
- Cover with plastic sheet; keep the beams moist
- Let the beams cure for 7 days before demoulding
- Store the beams for 2 weeks before use

Skills Required

- Special training is needed
- Engineer has to calculate reinforcement of beams

Equipment Supplier

No special equipment required

Costs for Equipment

No special equipment required

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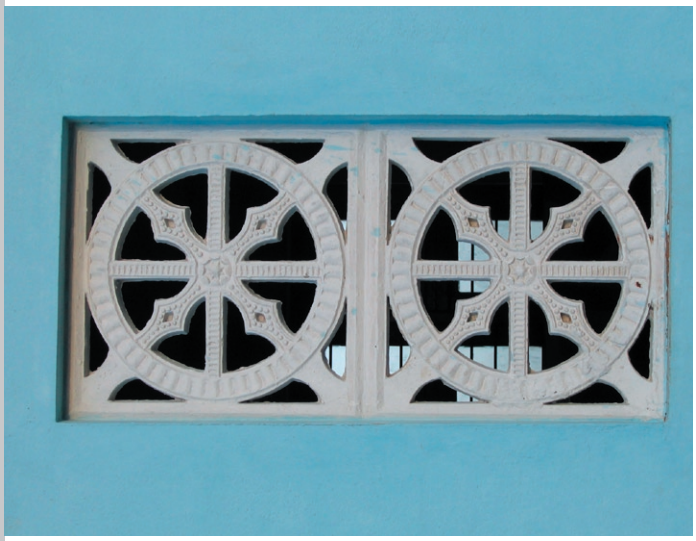
Rooster



Technical Data

Building element	Wall
Size	29 x 14.5 x 14cm (length x width x height)
Mixing ratio	1 cement : 6-8 aggregates
Cement used per m³	Depends on ratio and pattern
Resistance to earthquakes	Very good
Resistance to typhoons	Very good
Resistance to rain	Very good
Resistance to insects	Very good
Climatic suitability	All climates
Stage of experience	Widely used method
Production costs	Rp. 50,000
Durability	Approx. 30 years

Short Description

Ventilation Blocks (also known as Rooster) are widely used in walls (external and internal) to maintain necessary air circulation within buildings and screens. They can be also used for toilet parapets and fencing walls.

The empty spaces within the ventilation block can be designed according to the required volume of fresh air circulation.

Advantages

Technical Advantages

- Capability of being moulded into components of any shape and size
- Can have same size as concrete blocks
- Good stability, resistance to weathering, impact and abraison
- Easy to produce
- Can be easily built into walls
- More durable than window shutters

Economic Advantages

- Production can be started with little capital
- Can be massed produced
- Equipment to produce rooster can be easily made by local workshop
- Production of roosters can be easily combined with concrete blocks
- Can be an attractive business for small-scale enterprise

Limits of Application

- Can not be used as load bearing elements
- Raw materials must be locally available of good quality and economically viable
- Relative large amount of cement is needed which can be expensive and difficult to obtain
- Special knowledge and experience of the production process is needed

Raw Material

Cement

- Ordinary Portland Cement
- Special cements

Aggregates

- Sand and gravel
- Max. particle size of coarser aggregates is 10 mm
- Suitable aggregates are usually obtained from natural sources (river beds, gravel pits, volcanic deposits) or from industrial by-processes (granulated blast furnace slag, sintered fly ash)

Cement – Aggregate Ratio

- Suitable proportion of aggregate to cement must be found by testing
- Common ratio is 1: 5

Water-Cement Ratio

- Only drinking quality water should be used to mix the concrete
- Recommended water-cement ratio is 0.5

Equipment

- Mixers: Pan mixers, Trough mixers
- Matras Rooster
- Manual moulds
- Pallet
- Masonry tools

Costs for Equipment

- Manual press machine Rp. ####
- Semi automatic press machine Rp. ####
- Block mould Rp. ####

Production Process

1. Batching and mixing

- Batch aggregates and cement by weight
- Mix cement and aggregates using mattock, shovel or mixer until it reaches homogeneous condition
- Add some water
- In hot climates, the fresh mix must be shaded from the sun

2. Moulding

- Put the mixture into wooden or steel mould boxes or mould machine
- Demould blocks immediately after compaction.

3. Curing

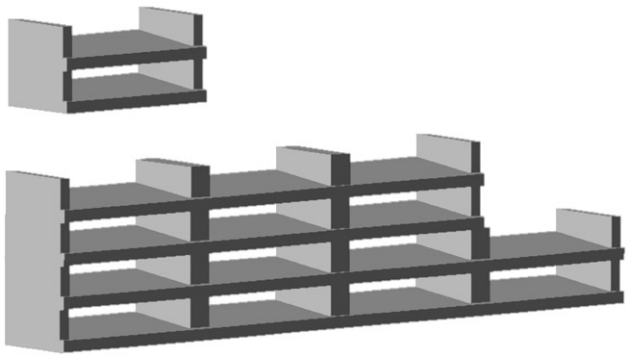
- Cover demoulded blocks with plastic sheets for 24 hours
- Keep the concrete blocks moist by keeping under water in tanks or by regularly spraying with water for 7 days

4. Storing

- Do not expose to direct sun light keep the blocks in a dry and covered area
- Store for 2 weeks before usage

Skills required

- Concrete making and masonry skills
- Special training at ArCli is recommended



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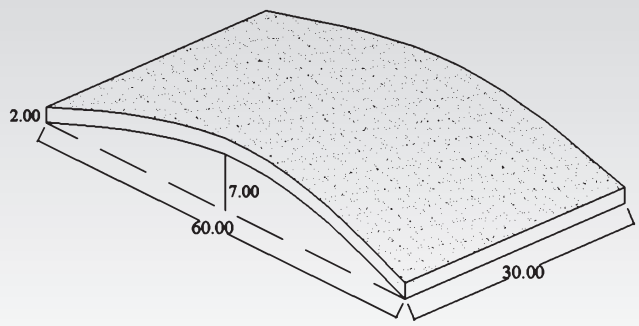
Curved Concrete Tile



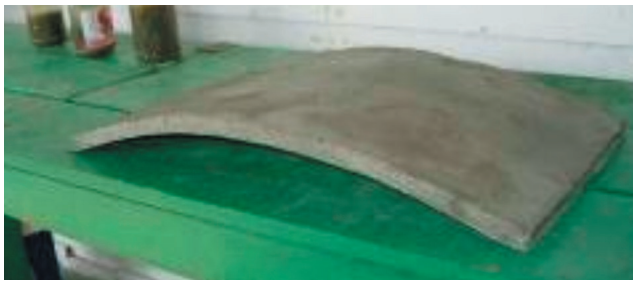
Technical Data

Building element	Tile of slab system
Mixing ratio	1 cement : 4 aggregates
Cement used per m³	460 kg
Resistance to earthquakes	Very good
Resistance to typhoons	Very good
Resistance to rain	Very good
Resistance to insects	Very good
Climatic suitability	All climates
Stage of experience	Experimental
Production costs per m²	Rp. 4,000- 5,000 per tile
Durability	Approx. 30 years

Short Description

- Curved concrete tiles are prefabricated and used in Slab Systems
- Tiles are manufactured using high strength concrete made of an optimised mix of cement, aggregate and water

Size: 30 x 60 x 2cm



Advantages

Technical advantages

- High structural strength
- No shuttering required
- Rapid construction

Economic advantages

- Production can be started with little capital
- Less wood is consumed

Limits of Application

- Skilled labourers required

Raw Material

Cement:

- Ordinary Portland Cement

Aggregate:

- Sand or gravel
- Max. particle size of coarser aggregates is 10mm
- Suitable aggregates are usually obtained from natural sources (river beds, gravel pits, volcanic deposits) or from industrial by-processes (granulated blast furnace slag, sintered fly ash)

Cement-Aggregate Ratio:

- Suitable proportion of aggregate to cement must be found by testing
- Common ratio is 1:4

Water-Cement Ratio:

- Only drinking quality water should be used to mix the concrete.
- Recommended water-cement ratio is 0.5

Steel reinforcement:

- U 24, U 39

Equipment

- Ordinary masonry equipment: spades pans, sieves, trowels, sand and cement batching boxes, balance, etc.
- Screeding machine: includes a vibrating surface and a hinged frame (MCR vibrating table)
- Testing equipment

Production Process

- Prepare the cement mix using cement, aggregates, and water (cement-aggregates ratio is 1:4)

- Apply cement on vibrating table and make it plane
- Apply and align the wet concrete tile on mould
- Let the freshly cast moulds dry for 24hrs to attain a minimum strength
- Demould the curved tiles
- Stack the tiles and cure them in water for minimum of 7 days

Skills Required

- Special training is needed
- Engineer has to calculate reinforcement of beams

Equipment Supplier

ArCli, Banda Aceh

Costs for Equipment

Tile production equipment incl. 100 tile moulds:
Rp. 15,000,000

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MCR Micro Concrete Roof

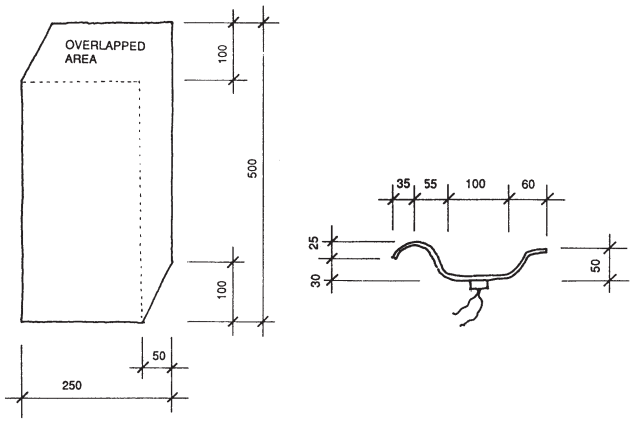
Technical Data

Building element	Roof
Size	25 x 50 x 1.0 cm
Mixing ratio	1 Cement : 2-3 Aggregates
Cement used per m²	5-7 kg
Weight per m²	37 kg
Resistance to earthquakes	Good
Resistance to typhoons	Satisfactory
Resistance to rain	Good
Resistance to insects	Good
Climatic suitability	All climates
Stage of experience	Mature technology
Production costs per m²	Rp. 26,000
Durability	15-20 years

Short Description

Micro Concrete Roofing (MCR) is a roofing technology developed 20 years ago. It consists of concrete tiles made of a cement mortar mix. MCR tiles are produced on a small vibrating table, which can be operated by a single trained worker. MCR allows for decentralised and small-scale production.

Dimension and shape:



Limits of Application

- MCR tiles are used for sloping roofs with minimum inclination of 20°; (25° in regions with tropical heavy rains or typhoons)
- Good quality raw materials are necessary to produce high quality MCR tiles.
- An MCR rooftop can not function as an area for gatherings, drying of cloth or placing aerial antennas, etc.
- In areas where there is no tradition in the use of concrete roof tiles, extra efforts to boost the product in the market are necessary.
- If MCR tiles are not painted, fungal and algal growth is common in tropical humid climates.
- The manufactory of MCR tiles should be located closely to the reseller's market (not more than 100 km) in order to reduce handling and transportation cost.
- Special training is required.

Advantages

Technical Advantages

- Good stability and durability, if properly manufactured and installed.
- MCR tiles are easy to handle.
- In hot climates, houses covered with MCR remain cooler compared to metal sheet roofs.
- MCR tiles are lighter than pressed concrete tiles.
- MCR tiles are more environmental friendly produced and recycled compared to metal sheet roofs.
- MCR can be produced in many different colours.

Economic Advantages

- Locally produced and low-cost
- Labour-intensive
- Only little investment is needed

Raw Material

Cement: Ordinary Portland Cement; Cement/aggregate ratio is 1:3

Aggregates consist of:

Sand: Angular particles and good grain size distribution between 0.06 and 2 mm (33%); free from silt and clay.

Gravel: Mix of grain sizes: 2-4 mm (33%), 4-6 mm (33%);

Sand/gravel ratio is 1:2

Water: Good quality water (drinkable water); water/cement ratio is 0.5-0.65 by weight

Admixtures: Waterproofers are used, if the sand is not well graded, and colorants, if the grey cement colour is not desired.

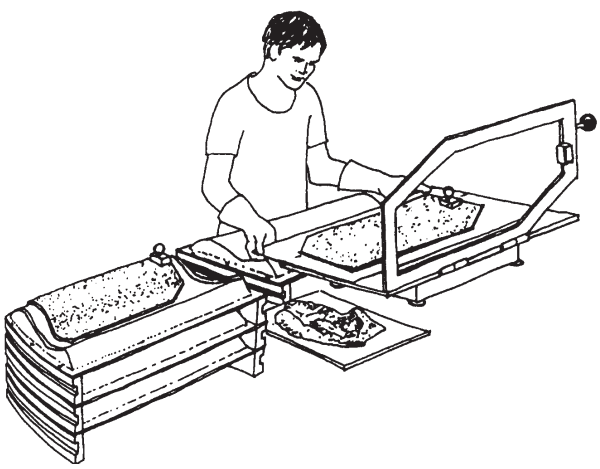
Equipment

- **Ordinary masonry equipment**: spades pans, wheelbarrows, sieves, trowels, sand and cement batching boxes, balance, etc.
- **Screeding machine**: includes a vibrating surface and a hinged frame.
- **Setting moulds**: made of impact-resistant PVC or fibre glass, with rib markings (for accurate positioning of the tile edge) and supporting frame for stacking.
- **Testing equipment**

Production Process

1. Prepare the aggregates (sand, gravel) in ratio 1:2
2. Mix cement and aggregates by using shovel, hoe or mechanic mixer. Then add sufficient water.
3. Put the wet mix onto the polythene interface sheet on the screeding machine and, under vibration, smooth with a trowel to the same level as the surrounding steel frame.

4. Lift off the steel frame from the screeding surface. Pull a polythene sheet over the PVC setting mould.



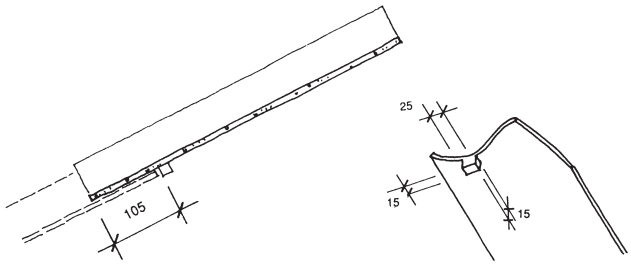
5. Place the mould with the fresh tile on a stack of moulds for initial setting and curing for 24 hours.
6. Demould tiles afterwards and let them cure for 2 weeks in water tanks.

Surface Treatment

- Painting of tiles with elastomeric or rubberised paints for a durable fungus-resistant top coat.
- Fungicidal washes such as sodium silicate, copper sulphate or even household bleaching.
- Painting needs to be re-applied after some years.

Installation of MCR

- MCR tiles are fixed well to the substructure in order not to be torn off by typhoon or earthquake.
- MCR tiles are laid on timber laths or steel angles (spaced at 40 cm).
- Fixed with wire loops, nailed or tied onto the timber laths or steel angles.



Skills required

Training from well-qualified and experienced resource persons is a must before an MCR production unit is established

Equipment Supplier

Parry Associates, UK
www.parryassociates.com

Eco Sur, Ecuador
ecosur@ecosur.org

TARA Technology and Action, India
www.devalt.org/TARA/

Appro-Techno, Belgium
www.appro-techno.com

Costs for Equipment

Vibrating screeding machine, 200 moulds, and accessory pack: Rp. 15,000,000

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Paving Blocks

Technical Data

Building element	Yards, sidewalks
Size	Various sizes
Mixing ratio	1 cement : 8-10 aggregate
Cement used per m³	250-300kg
Resistance to earthquakes	Very good
Resistance to typhoons	Very good
Resistance to rain	Very good
Resistance to insects	Very good
Climatic suitability	All climates
Stage of experience	Widely used method
Production costs per m²	Rp. 50,000
Durability	Approx. 30 years

Short Description

Paving blocks are prefabricated in many shapes and sizes. They are made of cement, aggregates and water.

They can be used for home yard floors, sidewalks or roads because of their high resistance to rain and heavy weather.

Size and shape are variable.

Advantages

Technical advantages

- Easy to produce
- High compressive strength, resistance to weathering, impact and abrasion
- Capability of being moulded into components of any shape and size
- Rapid laying
- Very good stability

Economic advantages

- Production can be started with little capital.
- Time and cost efficient to produce
- Time and cost efficient to install

Limits of Application

- Relatively large quantity of raw material is needed
- If paved area is used for vehicles, special preparation of the ground is needed

Raw Material

Cement:

- Ordinary Portland Cement

Aggregate:

- Sand and gravel
- Max. particle size of coarser aggregates is 10mm
- Suitable aggregates are usually obtained from natural sources (river beds, gravel pits, volcanic deposits) or from industrial by-processes (granulated blast furnace slag, sintered fly ash)

Cement-Aggregate Ratio:

- Common ratios are 1:8, 1:10
- Test the quality of blocks produced

Water-Cement Ratio:

- Only drinking quality water should be used to mix the concrete.
- Recommended water-cement ratio is 0.35 - 0.45

Equipment

- Masonry tools
- Mixers: Pan mixers; Trough mixers
- Moulding machine
- Moulds

Production Process

1. Batching and mixing:

- Batch aggregates and cement by weight
- Mix cement and aggregates using mattock, shovel or mixer until it reaches homogeneous condition

- Add some water

- In hot climates, the fresh mix must be shaded from the sun

2. Moulding:

- Put the mixture into wooden or steel mould boxes or moulding machine
- Demould blocks immediately after compaction

3. Curing:

- Cover demoulded blocks with plastic sheets for 24hrs
- Keep the concrete blocks moist by keeping under water in tanks or by regularly spraying with water for 7 days

Blocks cured in water tank

4. Storing:

- Do not expose to direct sun light; keep the blocks in a dry and covered area
- Store for 2 weeks before usage

Skills Required

- Concrete making and masonry skills
- Semi-skilled labour

Costs for Equipment

- Manual press machine Rp. ####
- Semi automatic press machine Rp. ####
- Mould Rp. ####

Equipment Supplier

Parry Associates, UK
www.parryassociates.com

TARA Technology and Action, India
www.devalt.org/TARA/

Appro-Techno, Belgium
www.appro-techno.com

Local suppliers

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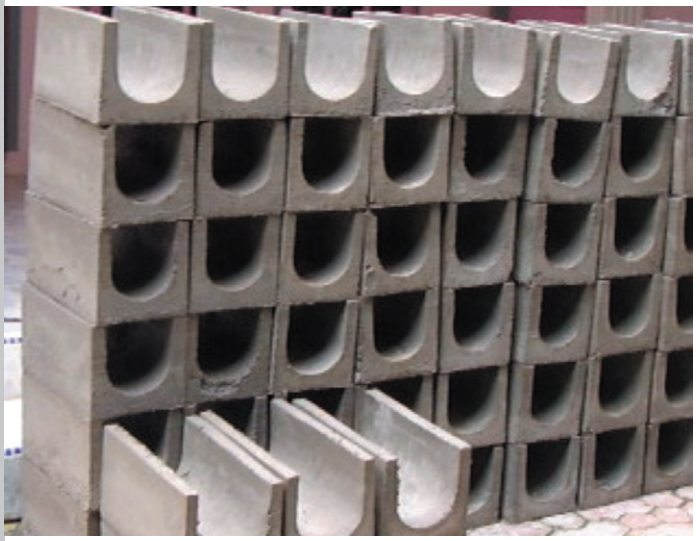
Beam Block

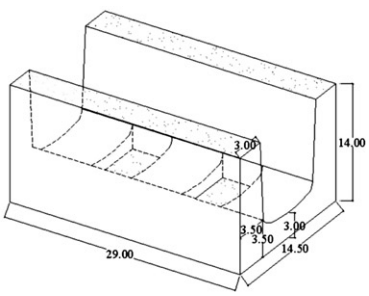


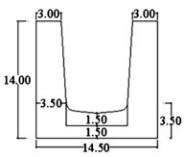
Technical Data

Building element	Wall
Size	14,5 x 29 x 14cm (width x length x height)
Mixing ratio	1 cement : 6-8 aggregates
Cement used per m³	250-300kg
Resistance to earthquakes	Very good
Resistance to typhoons	Very good
Resistance to rain	Very good
Resistance to insects	Very good
Climatic suitability	All climates
Stage of experience	Widely used method
Production costs per m	Rp. 7,500
Durability	Approx. 30 years

Short Description

Beam Blocks (u-shaped) are used for reinforced ground beams, lintels, and ring beams. The usage of Frame Block minimises wood consumption because formwork is no more necessary.





Advantages

Technical Advantages

- Very good stability
- For strong and light walls
- Rapid construction
- Voids can be filled with steel bars and concrete
- Are lighter in weight than solid blocks
- The cavity provides good thermal insulation

Economic Advantages

- Production can be started with little capital
- Less working time required for brick laying work with concrete blocks
- Less mortar consumption
- Generally, production costs of Frame blocks are slightly lower than of fired bricks

Limits of Application

- Raw materials must be locally available, of good quality and economically viable
- Relatively large amount of cement is needed, which can be expensive and difficult to obtain
- Special knowledge and experience of the production process is needed

Raw Material

Cement:

- Ordinary Portland Cement

Aggregates:

- Sand and gravel
- Max. particle size of coarser aggregates is 10mm
- Suitable aggregates are usually obtained from natural sources (river beds, gravel pits, volcanic deposits) or from industrial by-processes (granulated blast furnace slag, sintered fly ash)

Cement-Aggregate Ratio:

- Suitable proportion of aggregate to cement must be found by testing
- Common ratios are 1:6, 1:8

Water-Cement Ratio:

- Only drinking quality water should be used to mix the concrete
- Recommended water-cement ratio is 0.5

Equipment

- Blockmaking equipment
- Masonry tools
- Manual moulds

Production Process

1. Batching and mixing:

- Batch aggregates and cement by weight
- Mix cement and aggregates using mattock, shovel or mixer until it reaches homogeneous condition

- Add some water

- In hot climates, the fresh mix must be shaded from the sun

2. Moulding:

- Put the mixture into wooden or steel mould boxes or moulding machine
- Demould blocks immediately after compaction

3. Curing:

- Cover demoulded blocks with plastic sheets for 24hrs
- Keep the concrete blocks moist by keeping under water in tanks or by regularly spraying with water for 7 days

4. Storing:

- Do not expose to direct sun light; keep the blocks in a dry and covered area
- Store for 2 weeks before usage

Skills Required

- Concrete making and masonry skills
- Special training at ArCli is recommended

Costs for Equipment

- Manual press machine Rp. ####
- Semi automatic press machine Rp. ####
- Mould beam block Rp. ####

Equipment Supplier

Parry Associates, UK
www.parryassociates.com

TARA Technology and Action, India
www.devalt.org/TARA/

ArCli, Banda Aceh

Local suppliers

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Concrete Door & Window Frames

Technical Data

Building element	Door and window frame
Size	Various sizes
Mixing ratio	1 cement : 4 aggregates
Cement used per m³	460 kg
Resistance to earthquakes	Very good
Resistance to typhoons	Very good
Resistance to rain	Very good
Resistance to insects	Very good
Climatic suitability	All climates
Stage of experience	Commonly used
Production costs	***Please fill in!***
Durability	50 years

Short Description

Concrete doors and windows frames are an attractive alternative to wooden frames where there is scarce wood. And it can help to save wood and therefore to protect natural forest resources.

Advantages

Technical Advantages

- Good weather resistance
- High structural strength
- Fast construction
- Easy installation
- Flexible in use
- Frames can be adjusted to the building design
- Easy maintenance
- Good fire resistance up to 500°C

Economic Advantages

- Savings in working time through fast construction
- Cost-efficient and durable compared to wooden frames (up to 50% saving)

Limits of Application

- Raw materials must be locally available, of good quality and economically viable
- Special knowledge and experience of the production process is needed
- Formwork/moulds must be accurate and of very good quality, preferably made of steel
- Regular quality control is a must
- Fixing of hinges and locks require special skills
- Doors and window shutters must match with frames

Raw Material

Cement:

- Ordinary Portland Cement
- Special cements

Aggregate:

- Sand and gravel, max. particle size of coarser aggregates is 6mm
- Suitable aggregates are usually obtained from natural sources (river beds, gravel pits, volcanic deposits) or from industrial by-processes (granulated blast furnace slag, sintered fly ash)

Cement-Aggregate Ratio:

- Suitable proportion of aggregate to cement must be found by testing
- Common ratio is 1:4

Water-Cement Ratio:

- Only drinking quality water should be used to mix the concrete.
- Recommended water-cement ratio is 0.45
- Steel reinforcement

Equipment

- Masonry tools
- Mixers: Pan mixers; Trough mixers
- Frame moulds

Production Process

1. Batching and mixing:

- Batch aggregates and cement by weight
- Mix cement and aggregates using mattock, shovel or mixer until it reaches homogeneous condition

- Add some water

- In hot climates, the fresh mix must be shaded from the sun

2. Moulding:

- Put the mixture into moulds
- Let dry for min. 7 days
- Demould frames

3. Curing:

- Keep the concrete frames moist by keeping under water in tanks or by regularly spraying with water for 7 days

4. Storing:

- Do not expose to direct sun light; keep the frames in a dry and covered area
- Store for 2 weeks before use

Equipment Supplier

TARA Technology and Action, India
www.devalt.org/TARA/

bmtpc, India
www.bmtpc.org/machines/CC-1.htm

Local suppliers

Costs for Equipment

- Frame mould: 50-100 USD

Optional:

- Frame Moulding machine: ca. 1,000 USD
- Mixer machine: ca. 1,200 USD

Skills Required

Special training is needed

CEB Compressed Earth Block

Technical Data

Building element	Wall
Size	Various sizes
Mixing ratio	Cement/soil 1:5-10
Weight per m³	1,7-2,2t
Resistance to earthquakes	Good
Resistance to typhoons	Good
Resistance to rain	Good
Resistance to insects	Good
Climatic suitability	Suitable for all climates, except very wet climates
Stage of experience	Used in many countries
Production costs per m³	***Please fill in!***
Durability	50 years

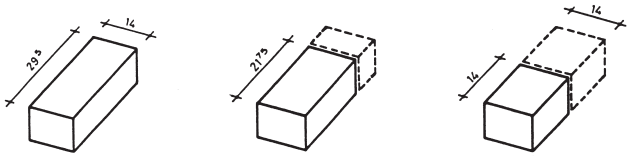
Short Description

To produce Compressed Earth Blocks (CEB), soil (raw or stabilised) is slightly moistened, poured into a steel press, and then compressed.

The usage of stabilisers allows building higher and thinner walls, which have a much better compressive strength and water resistance.

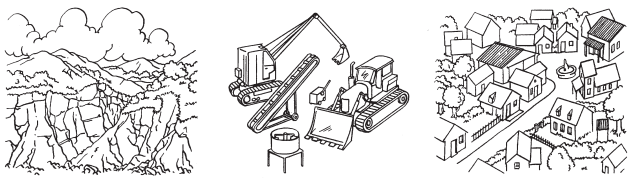
Various sizes and shapes can be produced.

A common size of CEBs in Indonesia is 22x10x8cm.



Advantages

- Environmental-friendly technology



Technical Advantages

- Good stability and strength
- Thermal insulation
- Very regular in size and shape
- CEBs can be produced in various shapes and sizes.
- Easy transportation of dried blocks

Economic Advantages

- Lower production cost and energy input compared with fired bricks
- Locally produced (less transportation costs)
- Flexible production size unit (from small scale workshop to large scale plant)
- Labour intensive. Creates jobs.
- Saves on wood consumption. No wood is required.
- Profitable business if well managed

Limits of Application

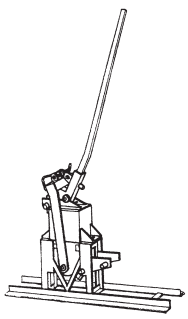
- Lack of good soil
- Lack of good equipment
- Cannot be used for big loads or in high rise buildings
- Cannot be used underwater or in continuously wet conditions

Raw Material

- Suitable soil with a good grain size distribution and a clay content of 10-25%
- Stabiliser (cement, lime)
- Waterproofing agents are optional

Equipment

- Block press (manually or motorised operated)
- Masonry tools (sieve, crusher, wheelbarrows, mixer, basic tools, PVC sheets, etc.)
- Quality control devices



Production Process

Preparation of the soil:

- Select soil with good grain size distribution and good cohesive performances

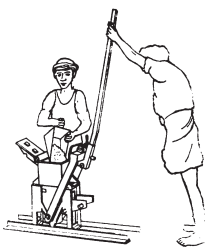
- Pulverise the raw material and sieve out clay lumps, gravel and stones

- Mix the prepared soil with the stabiliser

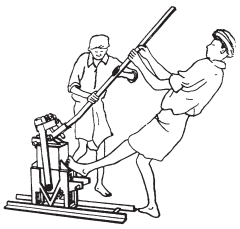
- Moisten the mix with water

Compression of the mixture:

- Pour into a steel press

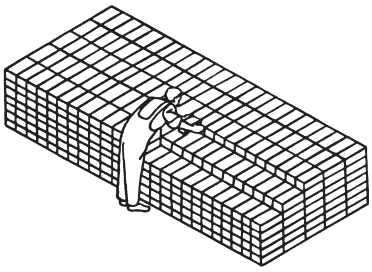


- Compress manually or motorised



Curing of the blocks:

- Stack the CEBs



- Keep the CEBs moist
- Cure for 4 weeks
- A hot and humid atmosphere gives best results
- Do not expose to sun and rain

Equipment Supplier

Development Alternatives, Delhi- India
Email: tara@devalt.org

Auroville Earth Institute
Auroshilpam, Auroville- India
Email: earth-institute@auroville.org.in

Parry Associates, UK
www.parryassociates.com

Fernco Metal Products
Email: fernco@ferncometal.com

Costs for Equipment

- Hand operated press machine costs ca. 900-1,200 USD
- Air/hydraulically operated press is ca. 1,800 USD

Skills required

Special training is needed

skat_ Swiss Resource Centre and Consultancies for Development

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Well Ring

Technical Data

Building element	Well Ring
Size	Variable
Weight per unit	125 kg (size: 90 x 30cm)
Mixing ratio	1 cement : 8 aggregates
Cement used per m³	300 kg
Resistance to earthquakes	Very good
Resistance to typhoons	Very good
Resistance to water	Very good
Resistance to insects	Very good
Climatic suitability	All climates
Stage of experience	Widely used method
Production costs per unit	Rp. 80,000
Durability	Approx. 30 years

Short Description

Well ring units are used to build wells, water tanks, latrines, and culverts.

Ring wells can be also used as supporting rings during the building of foundations. Well rings hold the surrounding soil and prevent it from collapsing during the casting of foundations.

Well rings can be produced in many sizes and shapes. The most common size is:

Outer Diameter: 90 cm
Inboard Diameter: 80 cm
Height: 35 cm

Advantages

Technical Advantages

- Can be produced in various shapes and sizes
- High compressive strength
- Resistance to soil acids, impact and abrasion
- Very good stability
- Easy to produce
- Rapid construction

Economic Advantages

- Production can be started with little capital
- Can be mass produced
- Is an attractive business for small-scale enterprises

Limits of Application

- Not recommended for overhead water tanks
- Raw materials must be locally available of good quality and economically viable
- Special formwork of steel or wood is required

Raw Material

Cement

- Ordinary Portland Cement

Aggregates

- Sand and gravel
- Max. particle size of coarser aggregates is 10 mm
- Suitable aggregates are usually obtained from natural sources (river beds, gravel pits, volcanic deposits) or from industrial by-processes (granulated blast furnace slag, sintered fly ash)

Cement – Aggregate Ratio

- Proportion of aggregate to cement can be optimized through testing
- Common ratio is 1: 8 (cement: aggregates)

Water-Cement Ratio

- Only drinking quality water should be used to mix the concrete
- Recommended water-cement ratio is 0.5

Equipment

- Mixers: Pan Mixers, Trough mixers
- Manual moulds
- Masonry tools
- Steel formwork

Skills Required

- Concrete making and masonry skills

Equipment Supplier

- Steel or wooden formwork can be produced locally

Production Process

1. Batching and mixing

- Batch aggregates and cement by weight
- Mix cement and aggregates using mattock, shovel or mixer until it reaches homogeneous condition

- Add some water

- In hot climates, the fresh mix must be shaded from the sun

2. Moulding

- Put the mixture into wooden or steel mould (round tun shaped)
- Let dry for min. 7 days
- Demould well rings

3. Curing

- Keep the well rings moist by keeping under water in large tanks or by regularly spraying with water for 7 days.

4. Storing

- Do not expose to direct sun light and rain
- Store for 2 weeks before usage

Costs for Equipment

- Steel formwork: Rp. #####
- Wooden formwork: Rp. #####

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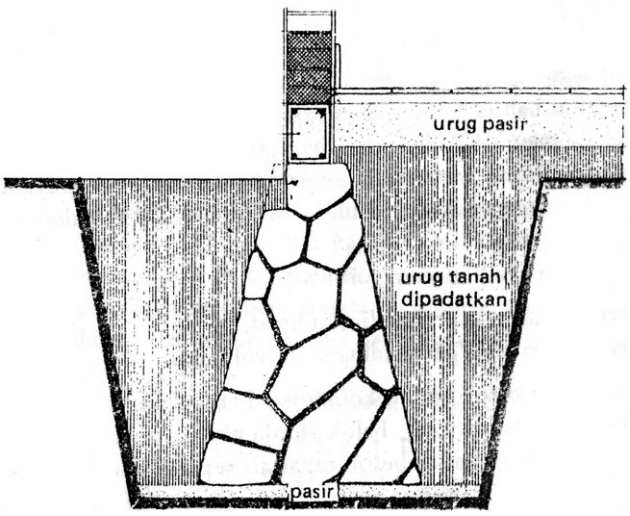
Rubble Stone Masonry Foundation



Technical Data

Building element	Foundation
Size	Width: 30-40cm Heigth: 80-150cm
Mixing ratio	-
Cement used per m³	-
Weight per m³	-
Resistance to earthquakes	Good
Resistance to typhoons	Good
Resistance to rain	Good
Resistance to insects	Good
Climatic suitability	All climates
Stage of experience	Widely used
Production costs per m³	Rp. 500,000
Durability	50 years

Short Description

Stone foundations are made of rubble stone. A similar construction is possible with concrete from demolished buildings.

The quality of mortar is of high importance to achieve good strength.

Suitable size of stones is 10-25cm.

Limits of Application

- Construction should start on firm, uniform, and strong subsoil
- Do not construct on grass, black fertile soil, filled up materials, or mud
- In earthquake areas, reinforcement with wire mesh or steel rods is required; professional advice should be sought

Raw Material

Stone:

- Cleaned rubble stone stone, or concrete pieces

Mortar:

- Made of cement, sand, and water
- The recommended ratio for cement/sand is 1:4
- The recommended water-cement ratio is 0.5

Advantages

Technical advantages

- Good stability
- Long lasting
- Raw materials are locally available and easy to transport
- Easy to be processed by semi-skilled labourers

Economic advantages

- Cost efficient to construct
- Generally, material costs are lower than of concrete foundations
- Processing can be started with little capital

Equipment

- Ordinary masonry tools

Production Process

- Prepare foundation trenches in the soil (min. depth 40cm)
- Apply a layer of lean concrete (min. 5cm) or tramped sand
- Mount carefully the stones in required width and height
- Keep joints as narrow as possible
- Fill all cavities well with mortar
- Refill foundation trenches
- Compact the refilling

Skills Required

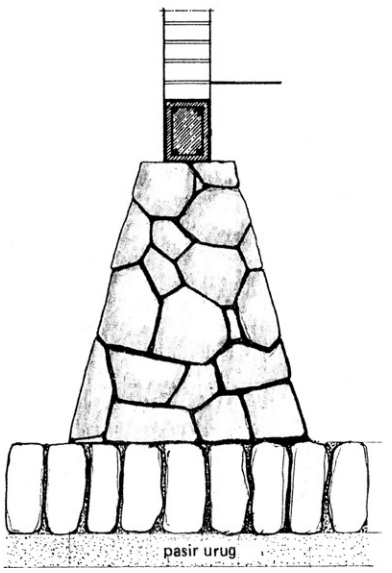
- Masonry skills
- Semi-skilled labour

Costs for Equipment

No special equipment required

Equipment Supplier

No special equipment required



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Prefabricated Concrete Footings

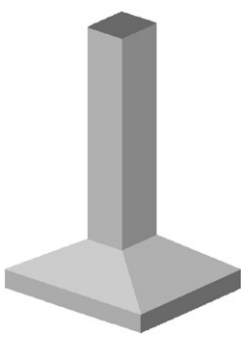
Technical Data

Building element	Foundation
Size	As per engineer's calculation
Mixing ratio	1 cement : 4 aggregates
Cement used per m³	Equivalent to P 350 (in CH)
Weight per m³	2,3 t
Resistance to earthquakes	Very good
Resistance to typhoons	Very good
Resistance to rain	Very good
Resistance to insects	Very good
Climatic suitability	All climates
Stage of experience	Commonly used
Production costs per m³	***Please fill in!***
Durability	Approx. 50 years

Short Description

Prefabricated concrete footings are a solid and durable alternative to rubble stone masonry foundations.

Concrete footings have a very good resistance to earthquakes and can be used in various types of grounds and soils.



Advantages

Technical advantages

- High compressive strength, resistance to weathering, impact and abrasion
- Capability of being moulded into components of any shape and size according to the type and pressure of the planned building, and the type of soil
- Rapid construction
- Very good stability
- Long lasting

Economic advantages

- Production can be started with little capital
- Time and cost efficient to produce
- Time and cost efficient to install
- In good soils and non-earthquake zones, footings can be made without reinforcement

Limits of Application

- Size and required reinforcement should be calculated by an engineer
- Raw materials must be locally available, of good quality and economically viable.
- Special knowledge and experience of the production and installation process is needed.
- The bottom of foundation has to be well prepared with a soling and neat for the placement of the footings

- Lifting equipment is required

Raw Material

Cement:

- Ordinary Portland Cement
- Special cements

Aggregate:

- Sand and gravel

Cement-Aggregate Ratio:

- Suitable proportion of aggregate to cement must be found by testing
- Common ratio is 1:4

Water-Cement Ratio:

- Only drinking quality water should be used to mix the concrete.
- Recommended water-cement ratio is 0.5

Reinforcement

- Steel bars of 12-16mm diameter, as per engineer's calculation

Equipment

- Ordinary masonry equipment: spades pans, sieves, trowels, sand and cement batching boxes, balance, etc.
- Mixers: Pan mixers; Trough mixers
- Moulds
- Reinforced concrete making equipment (spacers, steel cutter)
- Lifting equipment

Production Process

1. Batching and mixing:

- Batch aggregates and cement by weight

- Prepare the cement mix using cement, aggregates, and water
- In hot climates, the fresh mix must be shaded from the sun

2. Moulding:

- Prepare molds/formwork
- Place the steel bars and necessary brackets in the moulds

- Fill the cement mix into prepared moulds
- Demould footings immediately after compaction

3. Curing:

- Cover demoulded footings with plastic sheets for 24hrs
- Keep the concrete footings moist by keeping under water in large tanks or by regularly spraying with water for 7 days

4. Storing:

- Do not expose to direct sun light; keep the footings in a dry and covered area
- Store for 2 weeks before use

Costs for Equipment

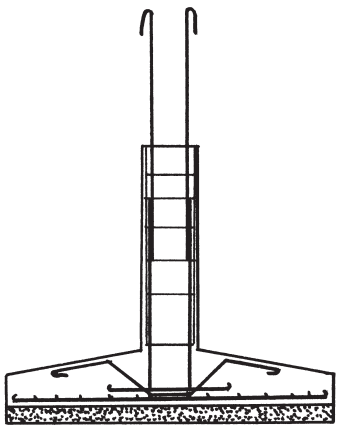
Has to be requested from ArCli, Banda Aceh

Equipment Supplier

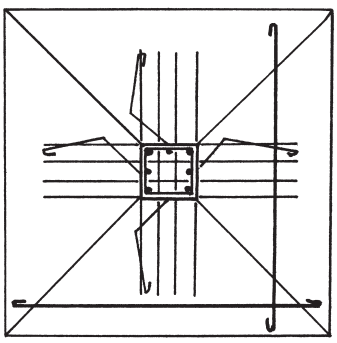
No special equipment needed

Skills Required

- Concrete making and masonry skills
- Skilled labour



Vertical section



Horizontal section

Wooden Roof Truss

Technical Data

Building element	Roof structure
Size	-
Mixing ratio	-
Cement used per m³	-
Weight per m³	-
Resistance to earthquakes	Good
Resistance to typhoons	Good
Resistance to rain	-
Resistance to insects	Needs protection treatment
Climatic suitability	All climates
Stage of experience	Commonly used
Production costs per m³	***Please fill in!***
Durability	50 years

Short Description

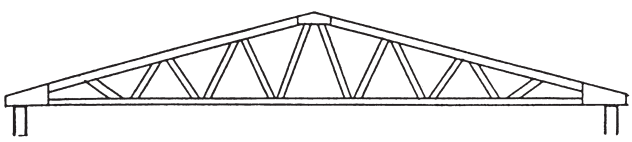
The wooden roof truss system is used as roof sub-construction. Different types of roof coverings can be combined with it.

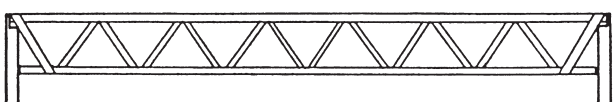
The wooden roof truss is a structure with straight members forming triangles to support a load. The pieces of the triangles are placed under tension and compression, but must not bend.

Roof trusses can be made for flat, single and double pitched roofs.

Joints of wooden roof trusses can be made with nails, bolts or plate connectors

Spans of nail trusses can vary from 6- 20m.





Advantages

Technical advantages

- Good stability
- Light weighted
- Suitable for construction in remote areas and at sites without lifting equipment. Can be handled manually.

Economic advantages

- Economic use of timber
- Mass production of trusses economises in production costs
- Advantage in transport and assembly compared to conventional roof structures
- Relatively small profiles required

Limits of Application

- Requires Engineer's calculation or use of Roof Truss Guide
- Timber must have good resistance against rot, insects and fungal attack
- Timber must be protected fully against weather impacts

Raw Material

- Timber of good quality and well dried
- Nails (min. tensile strength 600 N/mm²) or screws, or bolts
- Plate connectors

Equipment

- Carpenters tools

Production Process

Wooden roof trusses can be prefabricated or in situ assembled.

- Prepare a template by drawing the dimensions of the truss on a flat surface
- Cut the truss members and assemble them according to the template
- Prepare template for the nail fixing at the ends of the truss pieces
- Connect the timber pieces using nails, bolts or plates

Installation

- Trusses must be fixed properly to the supporting ring beam or column
- Wooden roof trusses need a carefully fixed bracing against wind forces
- Distance between the trusses depends on size of purlin and weight of roofing materials

Skills Required

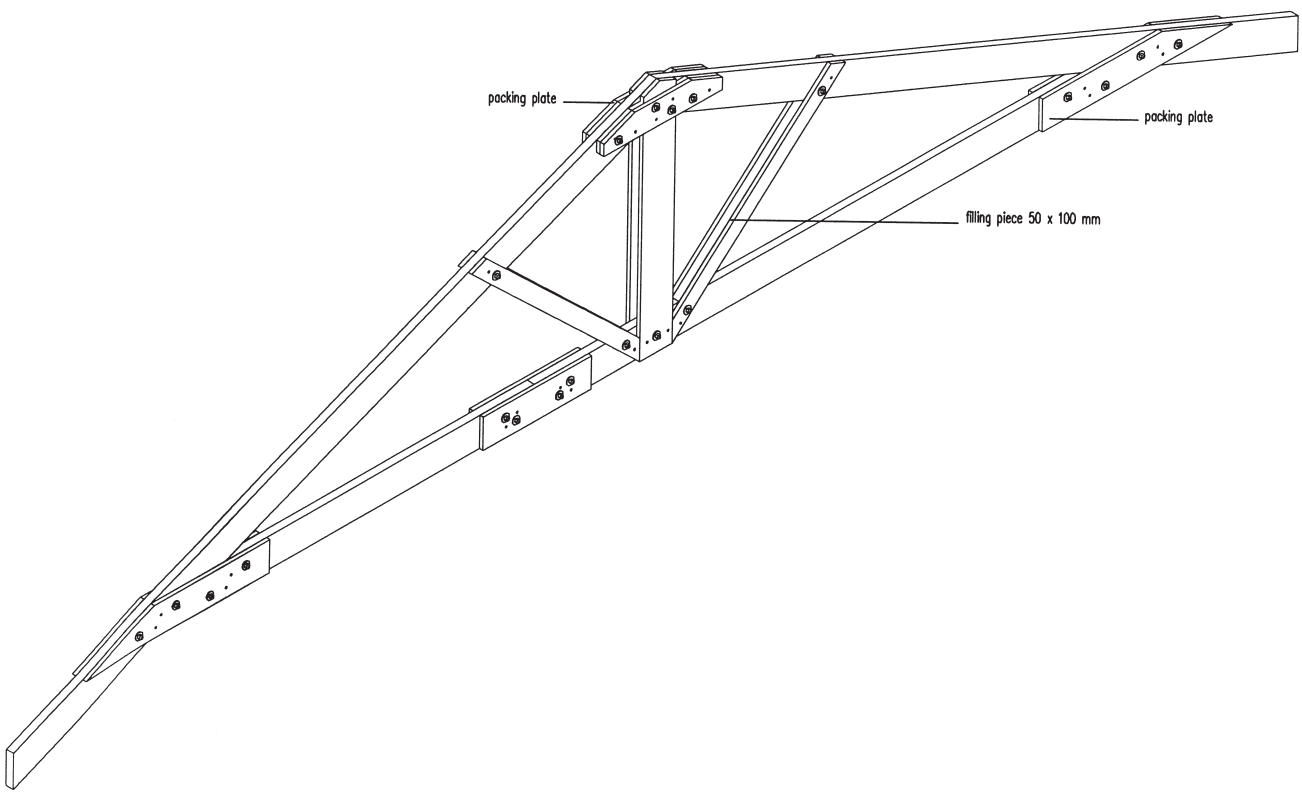
Good carpentry skills

Costs for Equipment

No special equipment required

Equipment Supplier

Local suppliers



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