MANUAL FOR FLY ASH BRICK MAKING

SHAKTI
SUSTAINABLE ENERGY FOUNDATION

BIHAR

Development Alternatives

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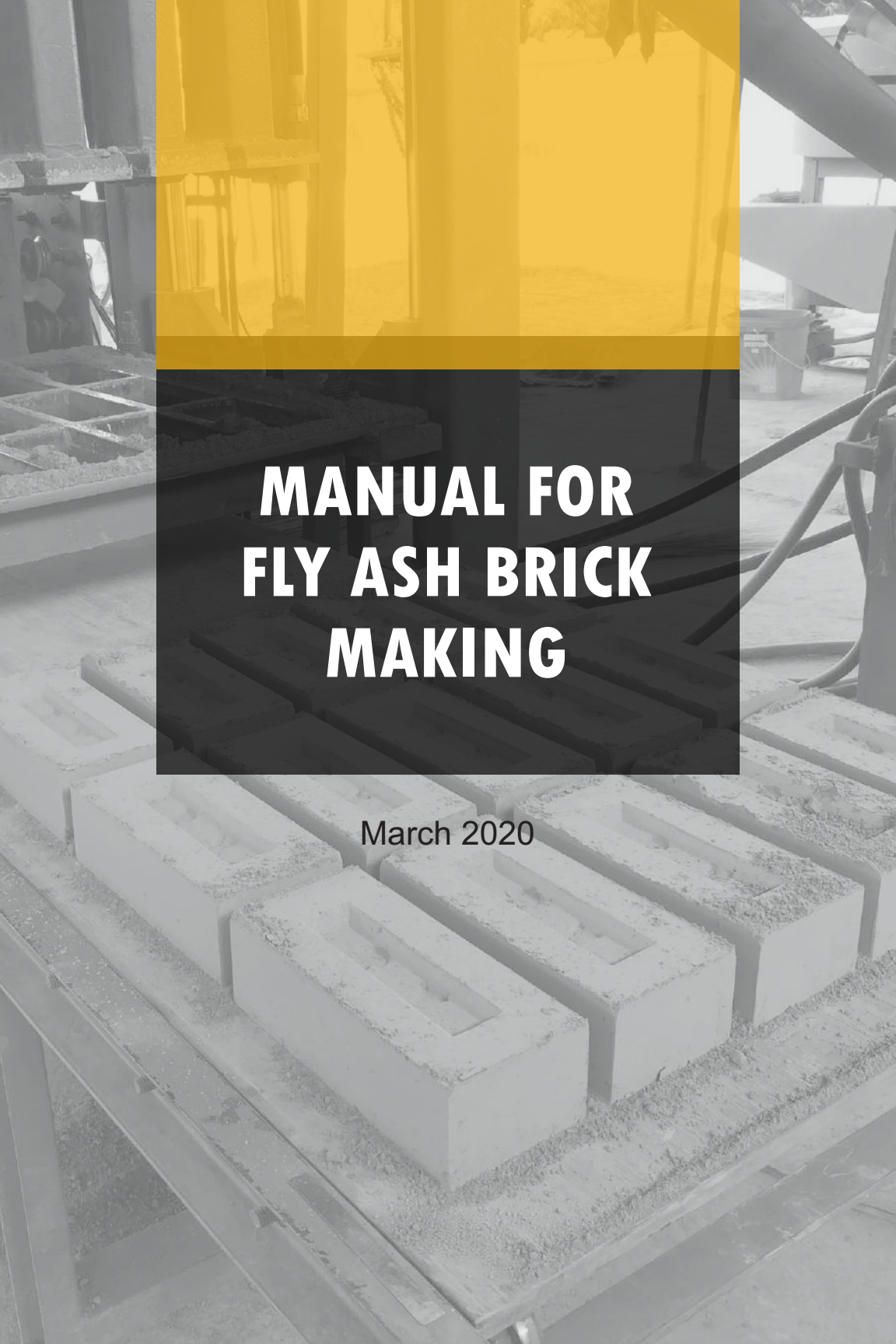


MANUAL FOR FLY ASH BRICK MAKING

March 2020

MESSAGE

It gives me immense pleasure to officially launch the Training Manual for Fly Ash bricks, which has been developed by the Bihar State Pollution Control Board (BSPCB) with active support from Development Alternatives, for promoting large-scale adoption of fly ash bricks in Bihar. The production and usage of fly ash bricks will lead to conservation of critical natural resources and mitigation of harmful air pollutants and GHG emissions thereby ensuring a sustainable growth for the state and the country. I am confident this manual will prove extremely beneficial to brick manufacturers, consumers like builders and contractors and other key stakeholders of the industry. In closing, I would also like to applaud the authors for their vision and efforts towards formulating this document.

(Sushil Kumar Modi)
Deputy Chief Minister, Bihar

MESSAGE

The fly ash brick presents a promising solution towards effective and widespread usage of unutilized fly ash in Bihar. This will result in mitigation of the negative effects from traditional brick production, thereby promoting inclusive development in the state. This Training Manual provides a detailed step-by-step guide towards production of high quality fly ash bricks and should prove beneficial to existing and potential brick entrepreneurs and other interested entities. I sincerely hope that the document will be warmly received by all relevant stakeholders and that it contributes towards development of a fly ash brick industry in the state. I would like to congratulate the Bihar State Pollution Control Board (BSPCB), Development Alternatives (DA) and Shakti Sustainable Energy Foundation (SSEF) towards launching such a crucial initiative in Bihar and further wish them the best going forward.

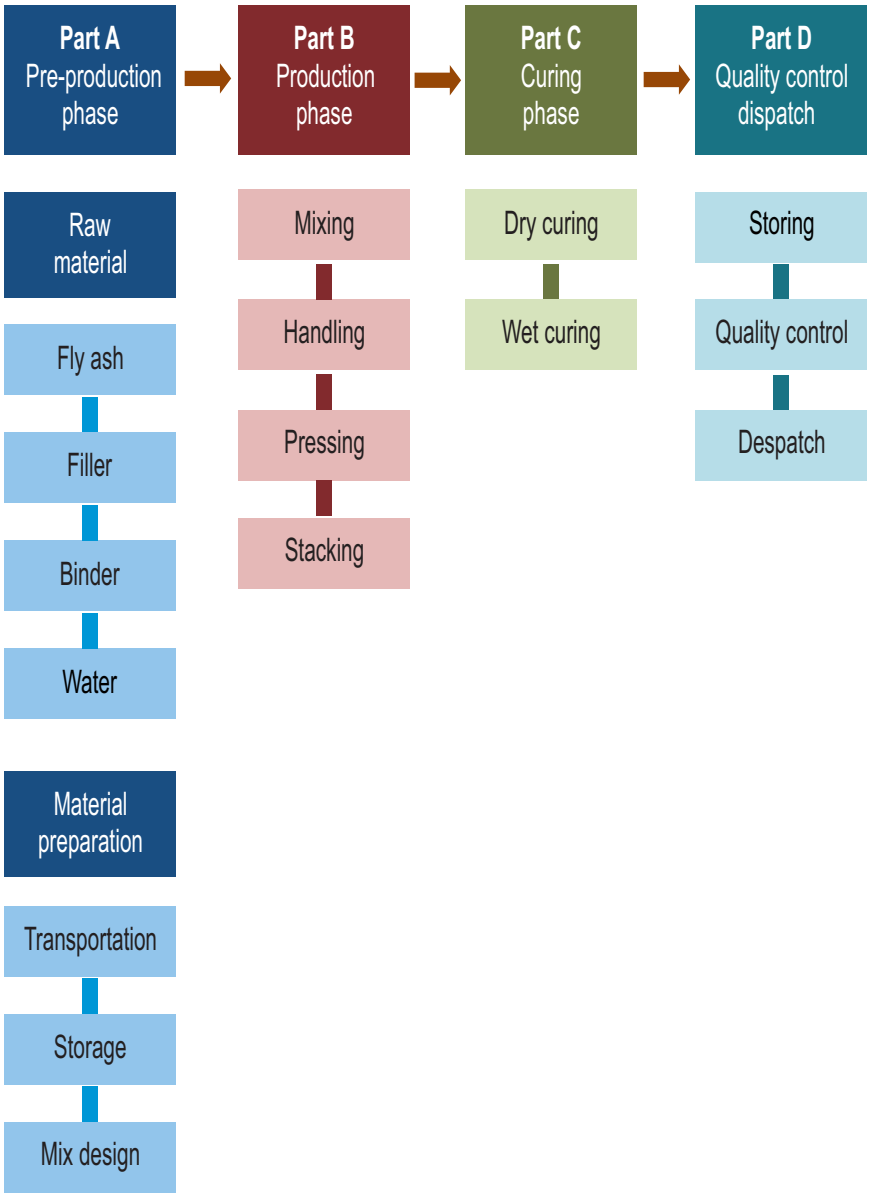
(Dipak Kumar Singh)
Principal Secretary, DOEF&CC Bihar

MESSAGE

The fly ash brick is a “zero” emission building material technology which uses waste materials, does not require polluting fuels (like coal, petcoke etc.) and avoids consumption of the precious top-soil. To support mainstreaming of the fly ash bricks in Bihar, a Training Manual for fly ash bricks has been developed by the Bihar State Pollution Control Board (BSPCB) and Development Alternatives (DA) (with active support from Shakti Sustainable Energy Foundation (SSEF)) for use by existing and potential fly ash brick manufacturers. This manual marks an important step towards achieving the principal goal of amplifying the uptake of fly ash bricks in Bihar by strengthening capacities of brick manufacturers to produce high quality bricks on a consistent basis. I sincerely hope that this manual fully achieves its intended purpose and that its readers would not just include existing and potential manufacturers, but regulators and policy makers, civil society, technology providers, builders and contractors and fly ash associations.

(Dr. Ashok Kumar Ghosh)
Chairman, Bihar State Pollution Control Board
(BSPCB)

FLY ASH BRICK PRODUCTION PROCESS



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Concepts and Specifications

Basic Concept

Fly Ash Block

- Cured building block
- Similar in properties to burnt blocks
- Uniform and regular size

Wall Properties

- Aesthetic look
- Low mortar consumption
- Normal block-mortar wall
- No plastering required (in some applications)

Physical specification

Used for
Normal wall construction

Material used
Pulverized fuel ash, coarse sand, lime, gypsum or cement

Shape
Regular or chamfered

Standard size

Modular	190mm x 90mm x 90mm
Non-modular	230mm x 110mm x 70mm

Weight

Modular	2.70 - 2.90 kg
Non-modular	2.80 - 3.10 kg

Production capacity
Varies from 2,500-30,000 blocks depending on the type of machine used

Specification and Quality Standards

All the specification and quality standards given below are as per IS Code 12894 : 2002 and IS Code 16720 : 2018.

Raw material specification

Pulverized fuel ash

Commonly known as fly ash, it should conform to Grade 1 or Grade 2 of IS 3812

Aggregates (Filler)

Commonly used are sand and stone dust. The fine and the coarse aggregates used shall conform to IS 383. The nominal maximum size of coarse aggregates used shall be passing 6.3 mm IS sieve. Undesirable materials such as clay and silt in sand shall preferably be less than 5%.

Binder (Cement)

Cement complying with any of the following Indian Standards may be used:

- Ordinary Portland cement, conforming to IS 269;
- Portland slag cement, conforming to IS 455;
- Portland pozzolana cement: fly ash based, conforming to IS 1489 (Part 1);
- Portland pozzolana cement: calcined clay based, conforming to IS 1489 (Part 2);
- Sulphate resisting Portland cement, conforming to IS 12330;
- Supersulphated cement, conforming to IS 6909;
- Rapid hardening Portland cement, conforming to IS 8041;
- White Portland cement, conforming to IS 8042;
- Hydrophobic Portland cement, conforming to IS 8043; and
- Composite cement, conforming to IS 16415.

For the production of fly ash bricks after the laboratory trials from all of the above-mentioned cements, Ordinary Portland Cement (OPC) grade 43/53 has been found to be the most suitable cement. So generally OPC 43/53 cement should be used in the production of fly ash brick.

Water

The water used in production of pulverized fuel ash cement bricks shall conform to the requirements specified in IS 456.

Chemical admixtures and Additives

Any suitable chemical admixtures, and additives such as gypsum and lime may be used provided they are not detrimental to the durability of the blocks. Chemical admixtures shall conform to IS 9103. Lime used shall conform to Class C hydrated lime of IS 712.

Product specification

Physical appearance

Visually the block should be sound, compact and uniform in shape. The block should be free from visible cracks, warpage and organic matters. Blocks shall have smooth rectangular faces with sharp corners and uniform in shape and colour.

Dimensions

Modular and non-modular sizes with dimensional tolerances of +-2mm

Compressive strength

Minimum wet compressive strength should not be less than 5.0 N/mm2 for Class 5.0. Higher classes will have higher strength.

Density

The pulverized fuel ash-cement bricks density when determined as per IS 2185 (Part 1) shall have density between 1100 kg/m3 and 2000 kg/m3.

Drying shrinkage

Average drying shrinkage should not exceed 0.15%.

Efflorescence test

Should not be more than “moderate” up to Class 12.5 and “slight” for higher classes.

Water absorption

Average water absorption not more than 20% by mass up to Class 12.5 and 15% by mass for higher classes.

Limitations

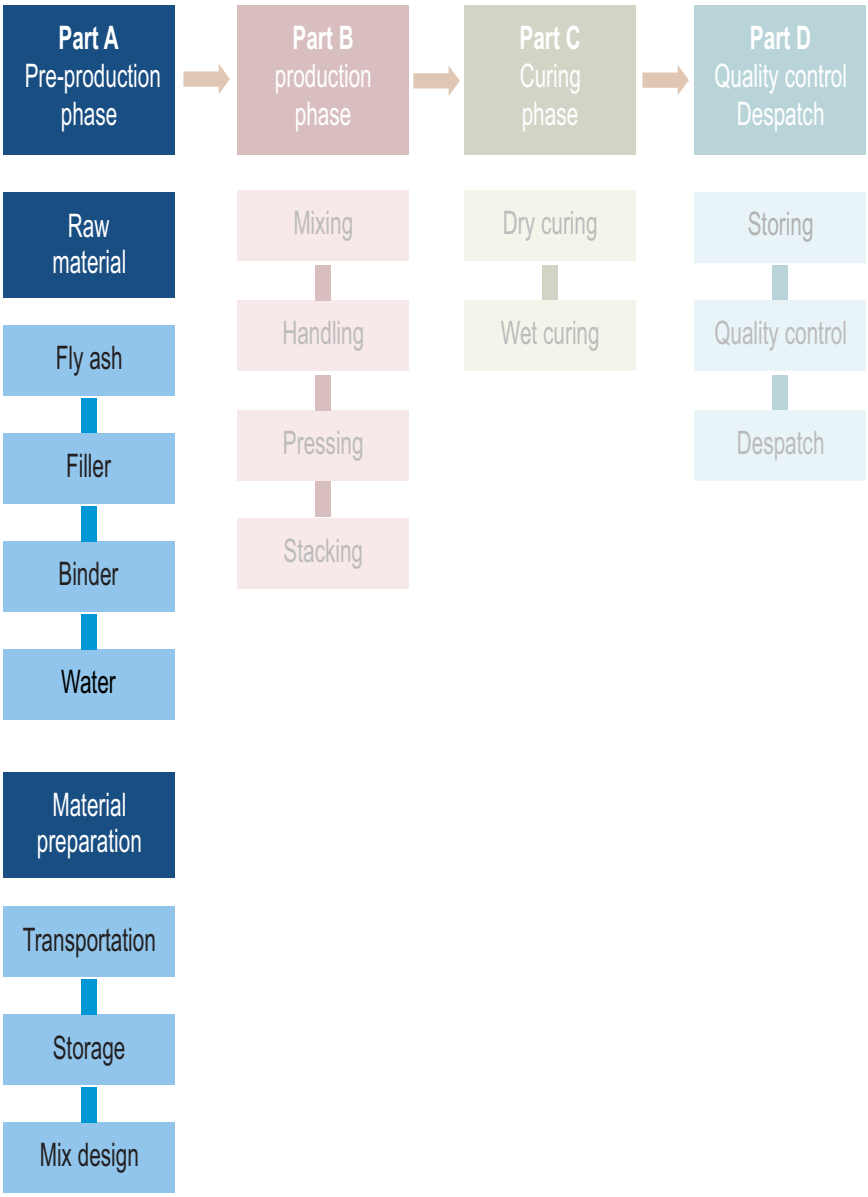
- Economically viable within 100 kms of a thermal power plant where ash is available
- Needs to be produced in proper hydraulic machines
- Need good masons for a good block work

Benefits

- No use of external energy in block making except electricity
- No environmental pollution due to burning of fossil fuel
- Use of industrial waste materials
- Reduced wastage due to mechanized block production
- No requirement of skilled manpower for block making
- Low land requirement compared to traditional block making
- 365 days of production with consistent quality

Classes of Fly Ash Bricks

Class Designation	Wet CCS N/mm^2	Wet CCS kg/cm^2 (approx.)
30.0	30.0	(300)
25.0	25.0	(250)
20.0	20.0	(200)
17.5	17.5	(175)
15.0	15.0	(150)
12.5	12.5	(125)
10.0	10.0	(100)
7.5	7.5	(75)
5.0	5.0	(50)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Raw Material – Fly Ash

Recommended practices

- In pulverized ash block production always use ash collected from silos or Electrostatic precipitators situated in ash collection areas of a thermal power plant
- Always collect and store ash in dry form
- Check the quality of fly ash at site with the “Fly Ash Testing Kit” for suitability in block making

Quality control

Visual/field test

- Fly ash should be free of any stones, foreign particles and organic matter
- Fly ash must be whitish in colour. The more whitish the ash, better the quality
- Take some fly ash and moist the same with little water. Press the moist dough between thumb and first finger. If the ash spreads into a very thin layer and sticks to the tips of the fingers then the ash is good for block making

Laboratory test

- Test the ash for calorific value. It should not be more than 1000 KCal/kg
- Specific gravity of ash should be greater than 1.80 gm/cm^3
- Loss of ignition measured as per standard procedures should not be more than 5%
- The particle size distribution of fly ash should be as follows:

Particle size	% content
Very coarse (> 1.18mm)	0.00 (nil)
Coarse (1.18mm – 0.60mm)	0.00 (nil)
Medium (0.60mm – 0.15mm)	5 - 10
Fine (0.15mm – 0.02mm)	70 – 80
Very fine (< 0.02mm)	15 - 20

Consequences

The use of low quality fly ash has the following consequences:

- Poor quality product
- High breakage during handling and transportation
- Reduced durability and life span
- High customer dissatisfaction leading to loss in business

Raw Material – Filler

Filler materials are used to provide crushing strength to the final cured blocks. Various types of filler materials can be used in fly ash block making. However the most commonly used and recommended ones based on business economics and quality are:

- Coarse sand
- Stone crusher industry dust

Filler – Coarse sand

For best results it is recommended to always use sand as filler with lime and gypsum as an additive.

Recommended practices

- Sand should be of siliceous origin or have similar origin
- Should be free from clay, soil or any other organic impurities
- Sand size should of 2mm for getting best results

Quality control

Visual/field test

- When sand is rubbed between hand palms, no dirt or stain should remain in the palm
- In a bottle test, the amount of finer materials should not be more than 4%. If more than 4% finer materials are found then an alternate source should be searched and the present lot rejected

Laboratory test

- The clay and silt content measured by a wet sedimentation process should not be more than 4%
- The following grading of sand is recommended for use in fly ash block production:

Particle size	% content
Very coarse (> 1.18mm)	0.00 (nil)
Coarse (1.18mm – 0.60mm)	85 - 95
Medium (0.60mm – 0.15mm)	5 - 15
Fine (0.15mm – 0.02mm)	0.00 (nil)
Very fine (< 0.02mm)	0.00 (nil)

Consequences

The use of improper and poor sand quality and grading has the following consequences:

- Use of ungraded sand results in poor quality of the finished product
- Use of higher particle size sand results in poor bonding and the fly ash block tends to disintgrate during water curing
- Use of lower particle size will result in poor strength. To compensate the same, higher quantity of additives will be required. This will result in higher product cost

Filler – Stone crusher industry dust

For best results it is recommended to always use stone crusher dust as filler with cement as an additive.

Recommended practices

- Stone crusher dust should be basaltic/granitic of origin. Lime in fine form is also beneficial.
- Should be free from clay, soil or any other organic impurities
- Should be sieved and used as per recommended size distribution

Quality control

Visual/field test

- When stone crusher dust is rubbed between hand palms, no dirt or stain should remain in the palm. Look also for fine dust in the palms. If fine dust is seen then the crusher dust should be washed before use
- In a bottle test, the amount of finer materials should not be more than 4%. If more than 4% finer materials are found then the present lot should be rejected

Laboratory test

- The finer material content measured by wet sedimentation process should not be more than 4%
- The following grading of stone crusher dust is recommended for use in fly ash block production:

Particle size	% content
Very coarse (6 mm - 1.18mm)	10 - 15 (nil)
Coarse (1.18mm – 0.60mm)	75 - 85
Medium (0.60mm – 0.15mm)	5 - 15
Fine (0.15mm – 0.02mm)	0.00 (nil)
Very fine (< 0.02mm)	0.00 (nil)

Consequences

The use of improper stone crusher dust quality and grading has the following consequences:

- Use of ungraded crusher dust results in poor quality of the finished product. During curing it might even result in cracks. The resultant block after curing will have no metallic ring and thus will not be accepted in the market.
- Use of higher amount of finer particle size will result in poor strength. To compensate the same, higher quantity of cement as additive will be required. This will result in higher product cost resulting in loss to entrepreneur.

Raw Material – Binder

Binders are used to bind the fly ash and filler materials thereby providing the required strength to the fly ash blocks. The most common and economic binders are a combination of lime and gypsum, or cement. Accelerators are generally not used due to cost considerations and possible adverse effects.

Binder – Lime

Recommended practices

- Lime should always be used in its pure form as possible with a CaO content higher than 60%
- Lime should always be used in the hydrated form
- Lime should be free from any impurities
- Waste lime (from textile, paper oxygen plants) can also be used subject to meeting the quality standards and determination of the actual quantity to be used through laboratory testing

Quality control

Visual/field test

- Take some lime (5 gm) in a test tube preferably in the powder state. Pour equal amount of common acid (muratic acid as found in the market). Shake the test tube till effervescence stops. Good and pure lime will not leave any residue.
- Dissolve some lime in water and prepare a milky solution. Mix more water to make an aqueous solution. Sieve the aqueous solution in a 100 mesh sieve. Good quality hydrated lime will not leave more than 1% un-dissolved solids in the sieve.

Laboratory test

Test of CaO content

- Test the lime sample for CaO content. The test can be done through the specially developed lime testing kit. Refer to Annexure for more details
- The CaO content of the given lime after hydration for 24 hours should be more than 60% of the total weight. This lime is suitable for use in block making
- Any lime (including waste lime) with less than 25% CaO content is NOT RECOMMENDED for use in production of fly ash blocks

Consequences

The use of improper lime has the following consequences:

- Poor quality product with low unacceptable strength
- The blocks made will crumble during the first day of wet curing
- High breakage during transportation and handling

Binder – Gypsum

Gypsum is never added singly. It is always added with lime to aid in reaction.

Recommended practices

Gypsum is used as a catalyst to the binder for making of fly ash blocks. It aids in early development of strength and reduced cracks in the blocks. To reduce costs phosphogypsum can also be used in fly ash block production. However it should be free from any impurities. Never use gypsum alone in fly ash block making.

Quality control

Visual/field test

- Good quality gypsum is always available in powder form
- Good quality gypsum is always white in colour. Thus more whiter the gypsum, better the quality

Laboratory test

- Take a small pinch of gypsum and mix a little bit water enough to make it moist. Rub the paste between two fingers. If coarse grits are felt, then the gypsum is not suitable for use

Consequences

The use of improper gypsum has the following consequences:

- Poor quality product with low unacceptable strength
- Heat of hydration cracks on the surface of the blocks

Binder – Cement

Cement is used primarily as a fast setting binder. Generally cement is preferred where stone crusher dust is used as a filler material. Sometimes in addition to lime, cement is also used in small quantities to provide initial handling strength to fly ash blocks For stabilizing blocks made of coarser particle size materials, cement is also preferred and give comparatively better results than lime based compositions.

Recommended practices

- Always use Ordinary Portland Cement (OPC)for the production of fly ash blocks. Do not use any type of pozzollana cement (PPC).
- 53 grade cement sets faster than 43 grade. Therefore it is recommended to use 53 grade cement wherever possible.
- Use only fresh and properly stored cement. Do not use cement that is lumpy or beginning to set, for the production of fly ash blocks.

Quality control

Visual/field test

- Cement should be free from any lumps or foreign particles.
- Cement from quality manufacturers should always be used e.g. ACC, Ultratech, Lafarge, Birla, Grasim etc.

Laboratory test

- Check the approximate setting time of cement through a cube test by forming a standard 1:2:4 mortar.

Consequences

The use of improper or poor cement has the following consequences:

- Very low development of strength during the initial setting period of 7 days resulting in a poor quality product with low unacceptable strength
- High breakage during the initial period of curing
- Higher damage during handling, storing, dispatch and transportation leading to loss in business and business credibility

Note: OPC and PPC can be identified by the following test. Take a small quantity of cement in a transparent glass beaker. Dissolve the same in water and stir. Allow it to stand for some time. If there are floating sediments on the top, then it is PPC. If no sediments are found at the surface of water, then the cement is of OPC grade.

Raw material – Water

Water is often overlooked but an important part of the block making process.

Recommended practices

- Water should always be clean and fresh, preferably standard portable water. It should be sourced from tubewells or industrial supplies. Water should neither be acidic nor alkaline in nature. It should not contain mud or clay or any other organic substances.

Quality control

Visual/field test

- Take a glass of water and check its turbidity and smell. If water is clean and transparent and does not smell, then it is usable for fly ash block production.

Laboratory test

- Check the pH of the water through litmus paper test. It should be neutral in nature. (6.5-7.5)

Consequences

- If water is acidic in nature, then it will react with the cement and result in very poor strength of the block produced.
- Poor quality water will slow down the lime hardening process resulting in poor quality of blocks.

Transportation, Storage, Mix design

Transportation

- Transportation of fly ash should always be done in covered vehicles
- For transportation of fly ash special vehicles are available which are easy to avail and can transport even 30 tonnes of ash in a single trip
- Transportation of cement, lime and gypsum should also be in airtight bags
- Care should be taken so that rain water does not damage the bags

Mix design

In general the following defines an correct mix design of a fly ash block:

During curing

- No cracking occurs during stacking just after pressing
- Air dried blocks does not disintegrate and develop cracks during water curing after 24 hours of air curing

After curing

- Compressive strength and water absorption
- Shape, size and finish with sharpness of edges and corners
- Economies of production

In general the mixing ratio of making a fly ash block depends on the quality of raw materials and the economies of production. The mixing ratio given below is only indicative and should be adjusted based on an entrepreneur's requirement.

Suggested mix design

(all compositions given are by weight)

Lime based compositions

- Fly Ash – 50-65%
- Coarse sand – 25-40%
- Virgin lime – 8-10%
- Gypsum – 2-4%

Cement based compositions

- Fly Ash – 50-70%
- Coarse Sand – 25-40%
- Cement – 8-12%; based on strength requirement of fly ash block.

General rules

- For actual production, all weights should be converted into volumes for ease of production.
- Mix ratio should be uniform. Each unit should establish their own mix ratio based on the quality of the raw material and the quality of block to be achieved.
- Always use dry ash and sand.
- Water/fly ash ratio should be physically verified and maintained.

Storage

A raw material store should be an enclosed space with no direct contact from sun, water, air and dampness.

Fly Ash

- Should be stored under cover.
- During summer or windy seasons, fly ash should be sprinkled with water every 2 hours to keep the surface moist to avoid dispersal in air
- Avoid fly ash being soaked with water during rainy season

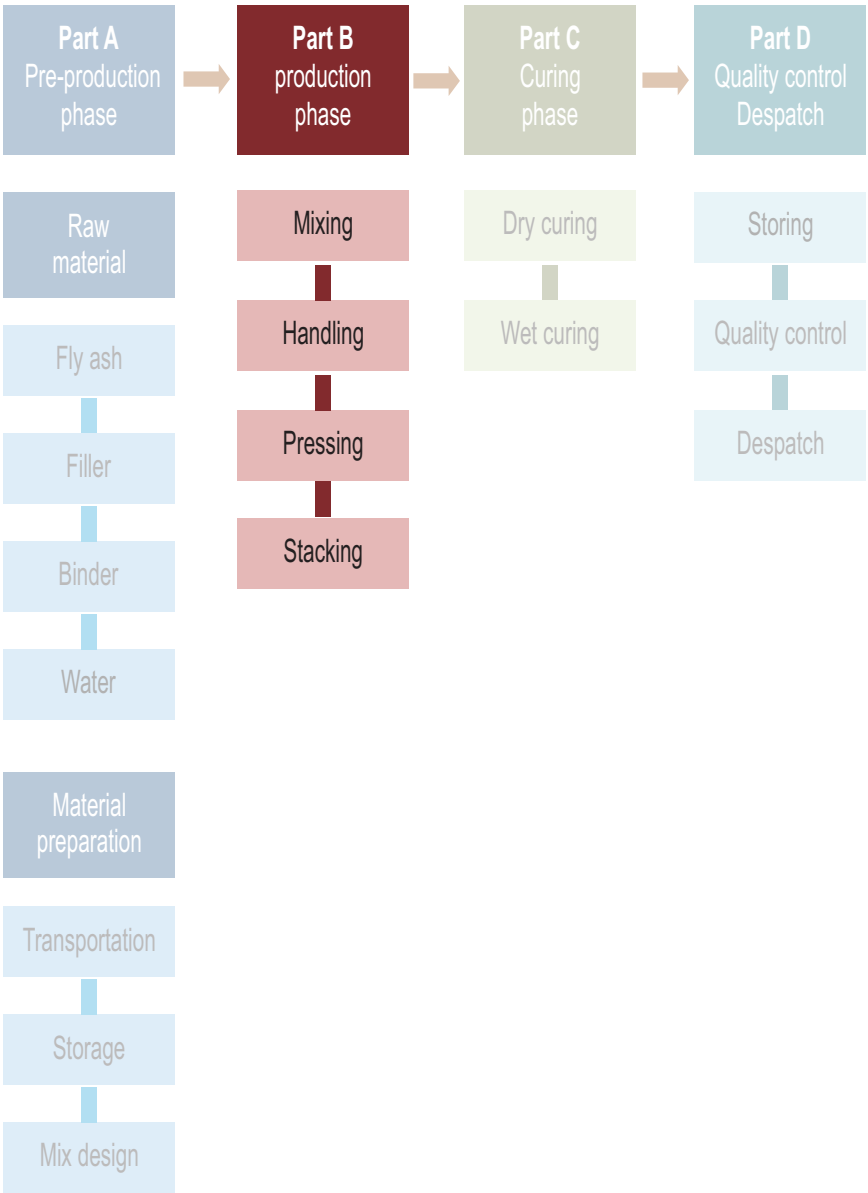
Filler materials

- Sand/stone crusher dust should always be stored in bins under a shed
- Sand/stone crusher dust should always be protected from rain so that moisture content cannot vary during the production process

Additives

- Cement, lime and gypsum should be stored in enclosed space with no direct contact from sun, water and moist air
- Stacking should always be done on wooden platforms
- Stacking platform should be atleast 15-20 cm above from the ground and 30-50 cm clear from the adjacent wall
- “First In – First Out” principle must be maintained for all additives

Half used bags should be sealed properly and preferable be used first the next day.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Mixing

Recommended practices

- Batching of raw materials should be done before production starts
- All raw materials to be mixed should be converted into volume. This is usually done to ease the working practice in production phase
- Each of the raw materials should be ready in required containers for mixing
- Usually volume containers for fly ash and sand are provided by the supplier for a uniform mix design. This should be checked for attaining the required quality. Otherwise the containers should be changed
- For additives, different sizes of containers (plastic bucket for ease in handling) for precise measuring of raw materials must be available
- Necessary tools like wire brush, scraper, measurement jar, trowel should be ready
- Water tank should be checked for water requirement and quality
- Mix to be prepared based on the recommended capacity of the mixer. Never overload the mixed capacity. This will lead to non-uniform mixes
- The prepared mortar mix should be used within an hour
- All prepared mortar mix should be unloaded from the mixer machine before loading a fresh batch

Mixing procedure

Step 1:

Required quantity of lime should be slaked in water as per batch requirement before 24 hours. Care should be taken so that there are no unslaked lumps.

Step 2:

Clean the pan mixer thoroughly. Grease the moving parts and oil the same. Start the machine and operate without load for 2 minutes.

Step 3:

Start the machine and put dry filler material. Let the machine run for 1minute so that the filler is evenly spread in the mixer.

Step 4:

Add additives (lime in slurry form and others in dry form) slowly at a time in the moving pan mixer. Care should be taken not to spill out the additive. Machine should be run for 2 minutes to uniformly mix the filler and additives.

Check the uniformity of colour of the mix. If uniform colour is achieved, then proceed to next step.

Step 5:

Pour the dry fly ash slowly. Allow the fly ash to be mixed with the filler and additives for atleast 3 minutes.

Check the uniformity of colour of the mix. If uniform colour is achieved, then proceed to next step.

Step 6:

Once homogenous colour of mix is achieved, pour small but adequate quantity of water at a time. Check for moistness of the mix through slump test.

Quality control

The purpose of mortar mixing is to achieve a uniform mix with a good workability for compression.

Visual check:

- Flatten the mist mix with a trowel. If properly mixed then a uniform colour will be visible. Check also for any white specks in the mix. If properly mixed then no white specks of unmixed lime will be seen.

  For mixing with cement as an additive no such white specs will be visible.

Manual check:

Squeeze test:

- Take a handful of mix and squeeze as hard as possible
- If the mortar sticks into the hand during opening of the palm then there is too much water in the mix
- If a small amount of visible water drips from the finger gaps then the mix is too wet

Slump test:

- Drop the squeezed mix from a height of 1 m on a hard and leveled surface, preferably cemented
- If the mix breaks into more than 2-3 pieces then the water content is too low
- If the mix slumps in one place like a small mound without breaking into any pieces, then the water content is absolutely right

Consequences

One of the most important but often overlooked aspect in fly ash block making is the mix design and the proper mixing of all raw materials and additives. The practice of poor mixing results in severe consequences, such as:

- Poor mixing results in non-uniform dispersion of additives thereby giving poor strength of the cured fly ash block
- If too much water is added then the mix will stick to the moulds resulting in poor finish of the fly ash block
- If too less water is added then blocks will crumble during handling or crack during water curing
- All of the above will result in poor quality and thus loss in profitability

Handling

Recommended practice

- All mixed materials should be taken out from the pan mixer before loading the subsequent charge.
- The mix is transported to the pressing machine through a conveyer belt.
- Check that the conveyer belt is uniform, with correct slope. Check the belt for any damage.

Quality control

- The mouth of the pan mixer may get jammed due the moist mix. Maintain a steady flow of the moist mix by releasing the jammed mix by poking with a small rod.
- Check for any unmixed lumps in the mix when transporting on the conveyer belt. All such unmixed lumps should be removed and returned into the pan mixer for remixing.
- If there is a high quantity of unmixed particles on the conveyer belt then check the mixing process in the pan mixer
- Coordination needs to be maintained between the pressing and the material handling. If the hopper is too full with materials then the conveyer belt carrying the moist mix should be stopped.

Consequences

- Inconsistent mixing is likely to choke the hopper and thus affect the machine productivity.

Pressing

Recommended practice

Pressing of the mix with optimum moisture gives the fly ash block its required shape, dimension and properties and thus is the backbone of the entire fly ash block business.

Step 1

Feed the mix from the pan mixer to the hopper through the conveyer belt.

Step 2

Turn on the automatic mould filler and scraper. Check for any unfilled pockets in the mould.

Step 3

Close and lock the mould.

Step 4

Apply required pressure through hydraulic system.

Step 5

Release the pressure so that the mould opens and the moulded blocks are ejected.

Quality control

It is to be noted that there are various machines that are available for pressing and shaping a fly ash block. These machines employ different process for block formation either through mechanical or hydraulic pressing. It has been found through years of research that hydraulic pressing is preferred for quality production of fly ash block making.

During pressing:

- Check that the mould is being filled completely and that there are no pockets
- Check the hopper for any moist lumps that are stuck to ensure a smooth flow of mix into the mould
- Check pressure gauge of the machine regularly to ensure that proper pressure is created

After moulding:

- After pressing check for uniformity in colour of the block. There should not be any colour difference resulting from non-uniform mixing
- Check the dimensions of the moulded block. It should be uniform
- Check the height of the block by a steel scale at all the four corners. They should be equal. If not then check the mould plates or the filling of the mould

If the height of the block is more than the recommended height then check the moisture content, mould depth and the pressure.

If the height is less than recommended, adjust the mould depth.

Consequences

The negative consequences of overlooking the pressing and moulding process are:

- Variance in height of the block resulting in toppling of blocks in stack. This also creates problem during laying and is thus rejected by customers
- Improper pressure will result in poor strength of the fly ash blocks

Stacking

Recommended practice

Step 1

After demoulding, blocks are kept one at a time on a wooden pallet.

Step 2

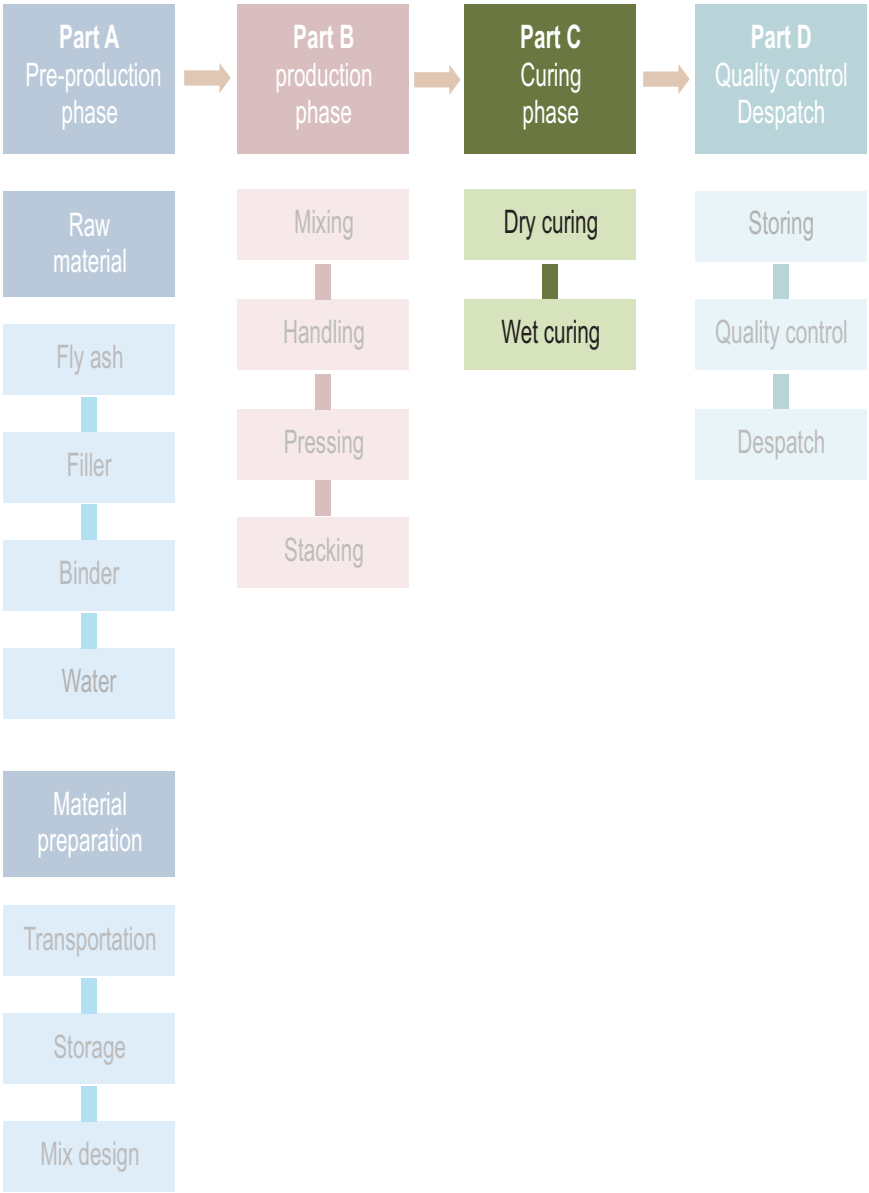
When required quantity of blocks are stacked on the wooden platform, the stack is removed with a hydraulic pallet trolley.

Quality control

- Before starting production check that the wooden pallets are leveled
- Check the height of green block stacking. It should not be more than 5 blocks at a time
- Check frequently whether the bottom most layer of blocks are cracking. If yes then check the level of the wooden pallets or the water content of the blocks
- Check that the entire block layer on a wooden pallet are horizontal and are uniform. If sloping is seen in a stack, then it will be due to non-uniform height of the blocks being formed. Check the pressure, base plate, height of the mould and the water content

Consequences

- Improper stacking of just moulded blocks results in high breakage and resultant loss in profitability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Dry and wet curing

Dry curing

Recommended practice

- Green blocks are dried up in open space to achieve initial setting.
- Dry curing is done on wooden pallets.
- Duration various depending on the atmospheric conditions. The following is followed as a general rule:
    - Summer month – 24 hr.
    - Winter month – 48 hr.
    - Rainy season – 48 hr.

Quality control

- During monsoon atmospheric curing should be done under a shed to avoid damage due to rain.
- Check the moisture content during summer months.

Caution

Wet curing follows the dry curing period.

Wet curing

Recommended practice

Wet curing of freshly made blocks is an important final step towards getting a good block property.

After 3 days of wet curing on wooden pallets, blocks are further stacked in higher heights. This type of closed stacking helps in wet curing by keeping the inner placed blocks always under wet condition.

Wet curing should be done for a period of atleast 14 days. After 14 days blocks are left to dry naturally.

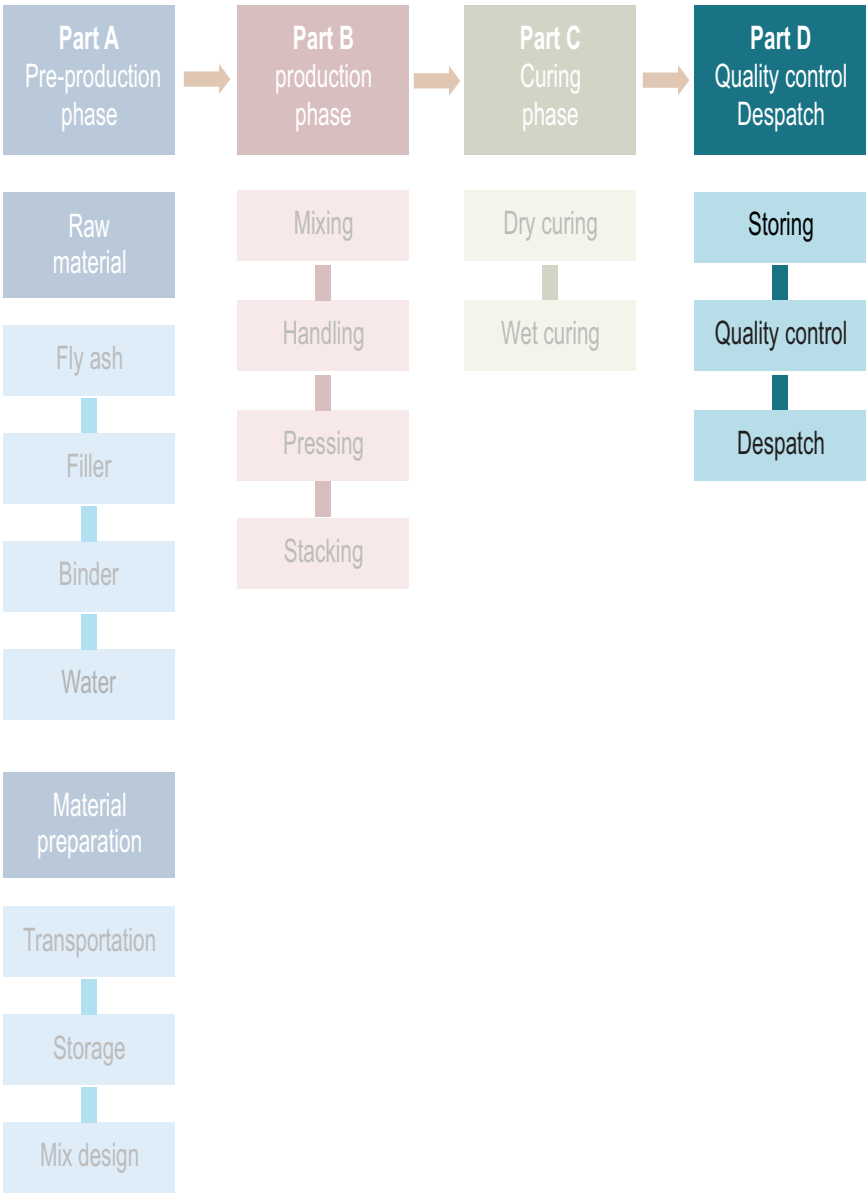
- Wet curing is always done with water.
- Water curing should be done once the green blocks attain leather hard condition.
- Curing should be done twice a day.
- Cover the block stacks with a black plastic. This will arrest water evaporation and ensure high temperature to aid faster curing

Quality control

- During the initial 3 days of wet curing care should be taken to avoid splashing rain. Rain drops falling on the blocks will make pitted structure thereby damaging the finish.
- Curing should always be done through a water sprinkler
- Ensure that the blocks are always in moist condition. It might be necessary to cure blocks twice a day especially during the summer months

Consequences

- Improper curing results in low buildup of strength and thus a poor block quality.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Storing

Recommended practice

There are no separate stacks for curing and dispatch. Once the curing over wooden palette is over i.e. the blocks gain sufficient strength to be moved, they are stacked in closed packs for 14 days under moist condition.

- Carefully handle the blocks during stacking and storing
- Remove any broken blocks
- Blocks should be kept moist for another 14 days by water sprinkling
- Mark the stacks are per the production date
- Keep enough space between stacks to ensure movement of trucks and transport

Quality control

The purpose of final storing and air curing is to let the blocks gain its final strength and quality. Therefore it is essential to:

- Water cure for atleast 14 days of production
- Keep the blocks wet as long as possible

Consequences

The negative consequences of improper storing are:

- Improper storing will incur higher breakages and damage within the stack. This will only be seen during dispatch thereby incurring high losses.
- If blocks are dispatched without proper curing then there might be higher breakage during transportation.

Quality control

Recommended practice

One of the most important and highly recommended production practice is to regularly test the raw material and the blocks that are being produced. This end control should be done on a regular basis and on random samples.

To do a proper end control, some essential and inexpensive testing equipment required. These tests are time consuming but will give an entrepreneur ability to understand the property of the product. Regular testing will also enable an entrepreneur to sell his product with much more confidence and guarantee. This will enable him to stand out against his competitors through quality. He might even charge a premium to give this service.

Quality control

The purpose of strict quality control is to ensure that only the best product reaches the end customer. This ensures total customer satisfaction essential for sustainability of any business. Therefore it is essential to make the following tests:

Own quality control laboratory

- Sedimentation analysis
- Lime test for CaO content
- Size and shape check
- Dry weight test
- Bulk density
- Ring test
- Compressive strength test
- Water absorption test
- Efflorescence test
- Abrasion resistance test

External laboratory

- Particle size analysis
- Calorific value of ash
- Chemical analysis

Consequences

The end control tests ensure business sustainability. It also shows the entrepreneur where his fly ash block production requires improvements.

If the end control tests are not performed then in the long run it will result in:

- Inability to stand against competition with other manufacturers
- Inability to know why, when and where to improve the production process
- Enterprise will earn a bad name and thus will affect business

Dispatch

Recommended practice

Ideally a fly ash block weight is on an average 2.80 kg. Thus a 10 tonne truck will be able to carry only around 3,500 blocks. Blocks may be transported by trucks or by tractors. Following suggestions should be considered during loading and dispatch of finished products.

- Load the blocks on edge
- Pack the blocks tightly so that they do not move during transportation
- If needed use sand bag packing to close gaps.

Quality control

The major reason of safe transportation is to deliver final and finished products with as much less damage as possible. Therefore it is essential to:

- Ensure that no broken/damaged blocks are loaded
- Ensure tight packing so that blocks are not moving against each other creating abrasion
- Ensure that the truck is not overloaded

Consequences

After all the hard work done during the entire production process improper loading and dispatch will cause high breakage during transportation. Thus careless loading will ensure that the profits of the business are run down the drain.

Shakti Sustainable Energy Foundation seeks to facilitate India's transition to a sustainable energy future by aiding the design and implementation of policies in the following areas: clean power, energy efficiency, sustainable urban transport, climate change mitigation and clean energy finance.

Bihar State Pollution Control Board (BSPCB) was constituted in the year 1974 under the provisions of the Water (Prevention and Control of pollution) Act, 1974. Enactment of the said Act and subsequently constitution of this Board was in pursuance of Clause-I of Article 252 of the Constitution of India. The Water Act, 1974 was made applicable in the first instance to the whole of 12 States and Union Territories, with Bihar being one of the said 12 States. Since its inception BSPCB, like other State Boards has been performing its functions of planning, monitoring, surveying, strengthening R&D, education and training activities in the domains of air, water, soil and noise pollution.

Development Alternatives (DA) is a premier social enterprise with a global presence in the fields of green economic development, social equity and environmental management. It is credited with numerous technology and delivery system innovations that help create sustainable livelihoods in the developing world. DA focuses on empowering communities through strengthening people's institutions and facilitating their access to basic needs; enabling economic opportunities through skill development for green jobs and enterprise creation, and promoting low carbon pathways for development through natural resource management models and clean technology solutions.

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