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Anil Agarwal Environment Training Institute

Understanding Zig Zag Kilns

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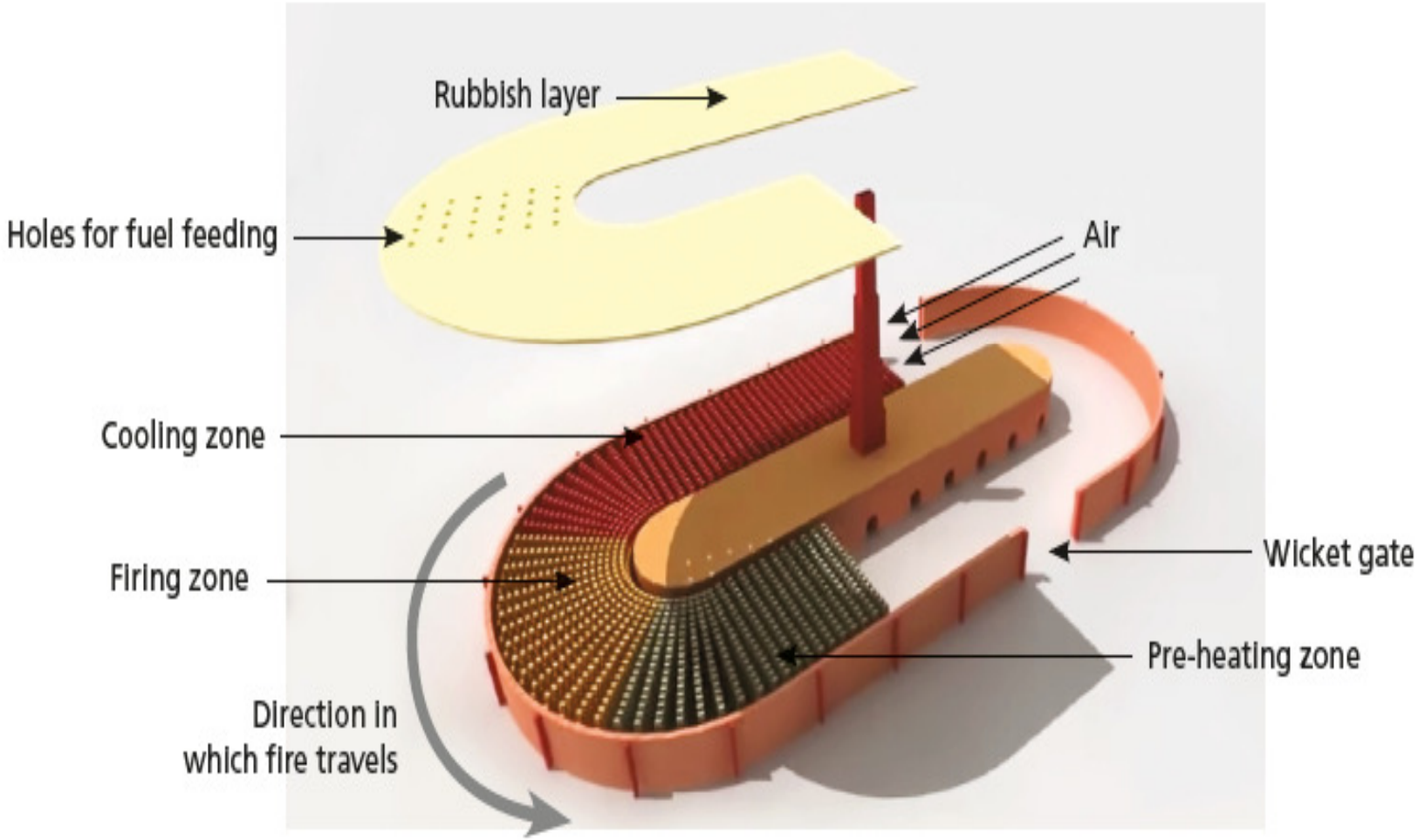
Schematic illustration of operations and firing zones of an FCBTK



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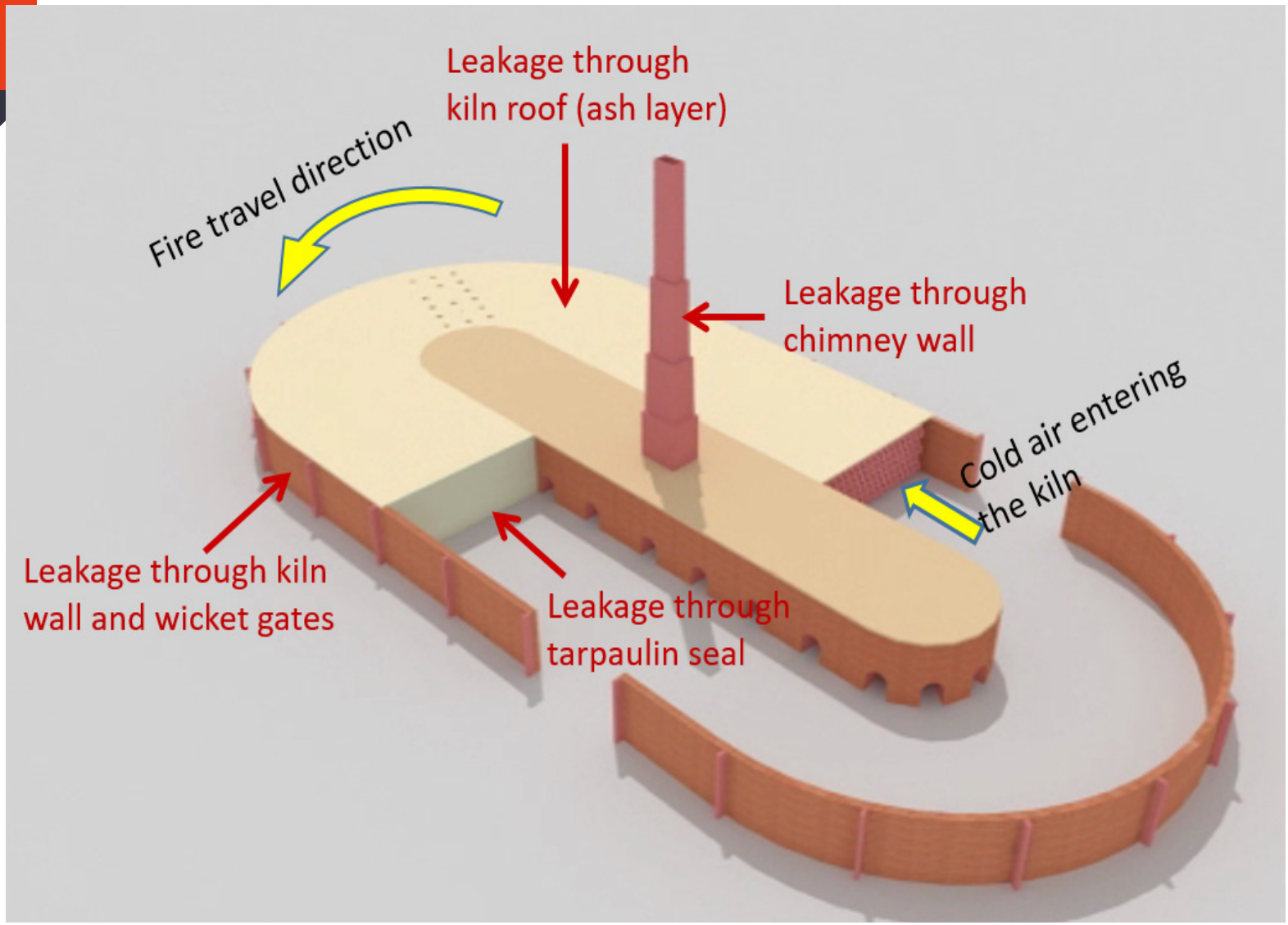
Problems With FCBTK Technology



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Problems With FCBTK Technology

- Air travels in a straight line and remains in the kiln for a shorter duration as the combustion zone is smaller. Therefore, the air does not get sufficient amount of time to properly mix with the fuel, resulting in incomplete combustion.

- Improper distribution of heat in different parts of the combustion zone is another major downside of an FCBTK. Green bricks stacked for firing are not exposed to a uniform temperature and only 60 per cent of the bricks fired turn out to be Class I (good quality).

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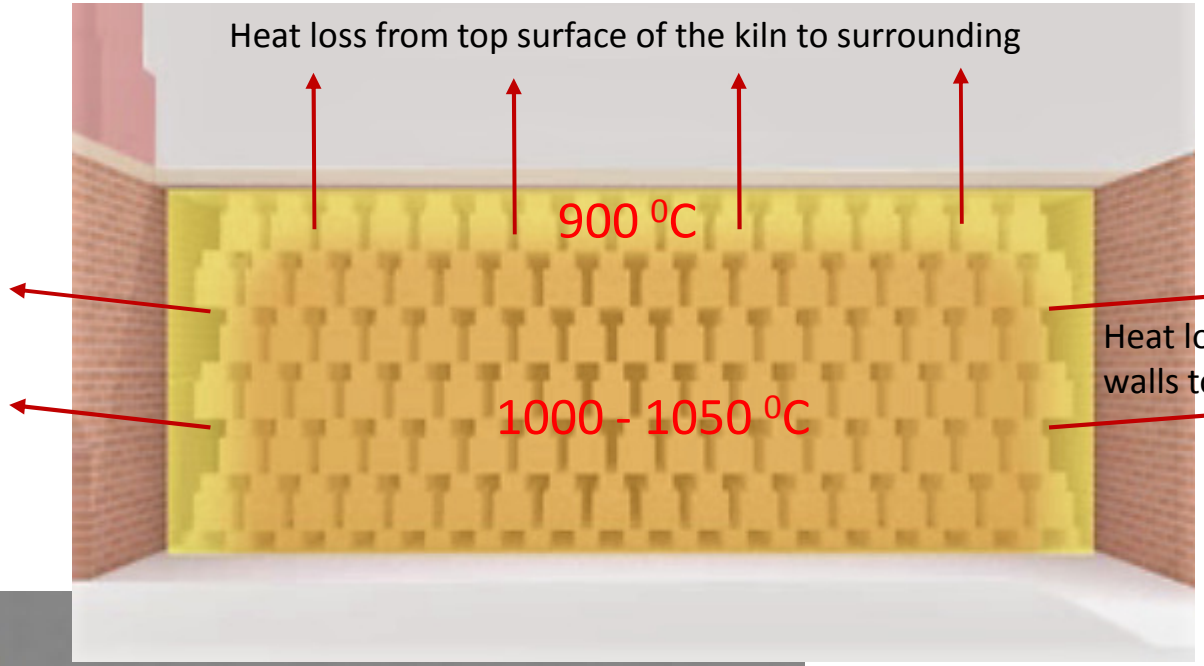
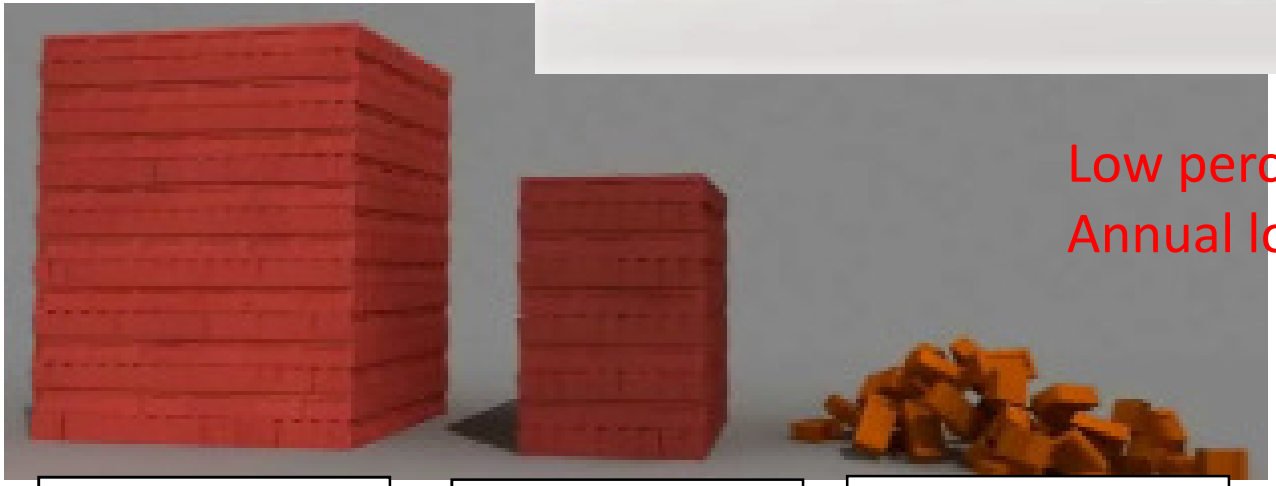
Non-Uniform Temperature Distribution in the Kiln





Low percentage of Class-I bricks –
Annual loss of Rs 10-15 lakh/year

Class – I: 50-60%

Class – II: 30-35%

Breakages: 10-15%

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Zig Zag Kilns

- What are the things to be taken into account
- Size and dimensions of each kiln component?
- Per day number of bricks to be produced?
- Time Requirement?
- Equipments required?
- Techno-economics?

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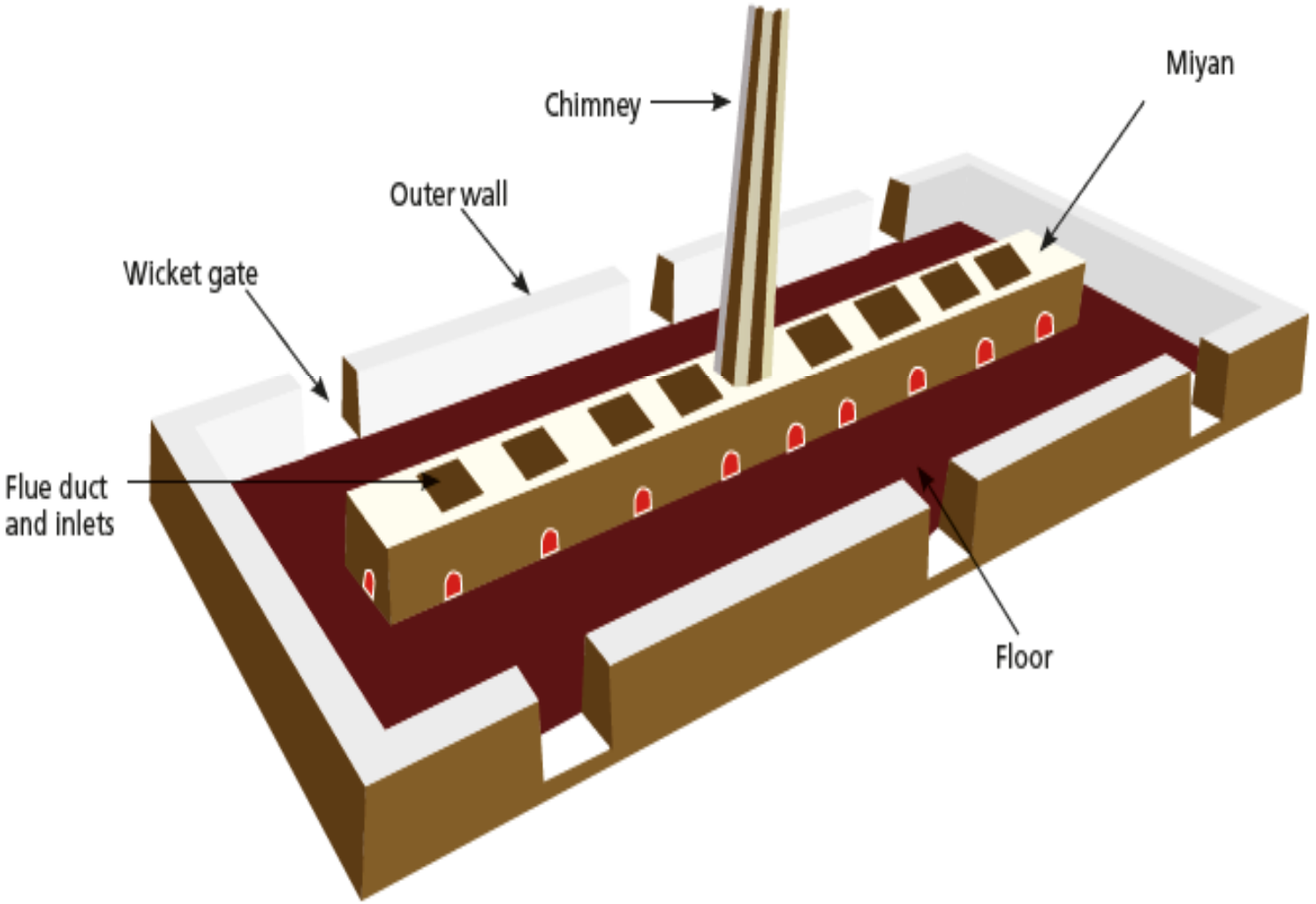
Main Components of the Kiln



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Main Components of the Kiln

- Dug width
- Dug well height
- Chamber length
- Side nali spacing
- Gali width
- Miyan dimensions
- Kiln outer dimensions
- Flue duct system
- Kiln wall
- Wicket gate or dwari
- Kiln floor
- Chimney

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Dimensions of a typical natural draft zigzag kiln

Bricks/day	Trench/dug width	Chimney height	ID bottom*	ID top*	Height of main nali	Width of main nali	Gali size
21,000	18 ft	120 ft	9 ft x 9 ft	3 ft x 3 ft	4ft	2.5ft	9 ft
25,000	22 ft	135 ft	9 ft 6 in x 9 ft 6 in	3 ft 2 in x 3 ft 2 in	4ft	2.5ft	11 ft
30,000	23 ft 6 in	135 ft	9 ft 6 in x 9 ft 6 in	3 ft 2 in x 3 ft 2 in	4ft	2.5ft	11 ft 9 in
36,000	26 ft	135 ft	10 ft x 10 ft	3 ft 4 in x 3 ft 4 in	4.5ft	2.5ft	13 ft
39,000	28 ft	140 ft	10 ft 6 in x 10 ft 6 in	3 ft 6 in x 3 ft 6 in	4.5ft	2.5ft	14 ft
41,000	31 ft	140 ft	10 ft 6 in x 10 ft 6 in	3 ft 6 in x 3 ft 6i n	4.5ft	2.5ft	15ft
44,000	33 ft	145 ft	12 ft x 12 ft	4 ft x 4 ft	5 ft	2.5 ft	16 ft 6 in
48,000	35 ft	145 ft	12 ft x 12 ft	4 ft x 4ft	5 ft	2.5 ft	16 ft 6 in
52,000	37 ft	145 ft	12 ft x 12 ft	4ft x 4ft	5 ft	2.5 ft	16 ft 6 in
58,000	39 ft	150 ft	13 ft x 13 ft	4 ft 4 in x 4 ft 4 in	5 ft	2.5 ft	16 ft 6 in

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Dimensions of a typical induced draft zigzag kiln

- A minimum height of 27m (approximately 90 feet) has been mandated by MoEF&CC for brick kilns in its new draft standards

- And for all other dimensions kept constant in the above table, generally 10000 more bricks per day can be produced in an induced draft Zig-Zag Kilns

- In an induced draft kiln, the draft is created with the help of a fan. The capacity of the fan depends on the trench width and the number of bricks to be produced per day (Generally 12 – 15 HP fan is used)

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Dimension of main components

DUG WALL HEIGHT

- The dug wall or miyan wall height is the height measured from the dug surface. It is generally 10–11 feet

CHAMBER LENGTH

- In general, the length of the chamber varies from six to nine feet. Better zigzagging of the air flow can be achieved by decreasing the length of the chamber. Therefore, six feet long chambers are recommended for both induced and natural draft zigzag kilns.

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FLUE DUCT SYSTEM

The flue duct system consists of designing the size and dimensions of following components:

- Main nali (main flue gas inlet)
- Side nali (side flue gas inlet)
- Vertical hall or mangal

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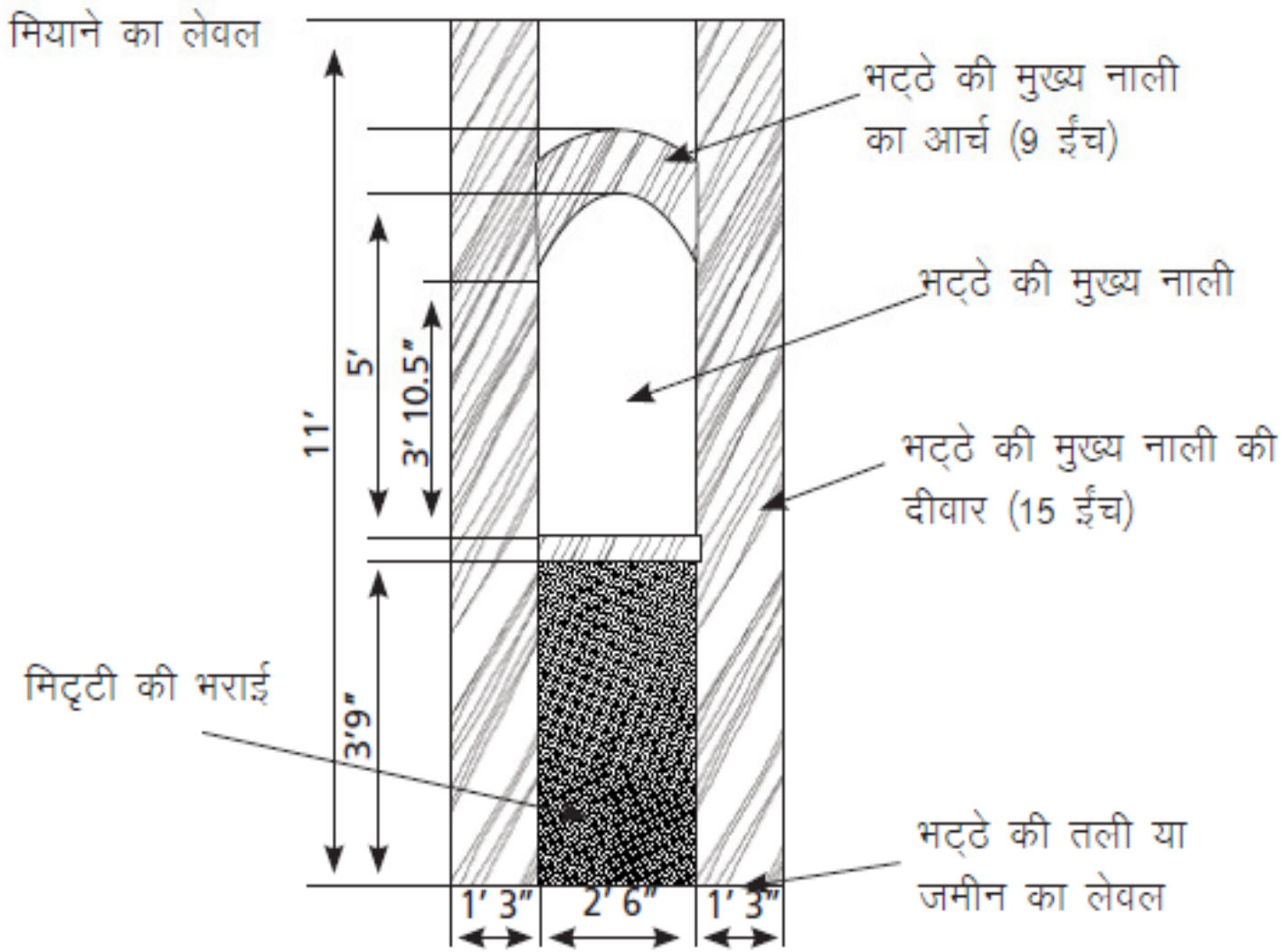
Schematic of a main nali



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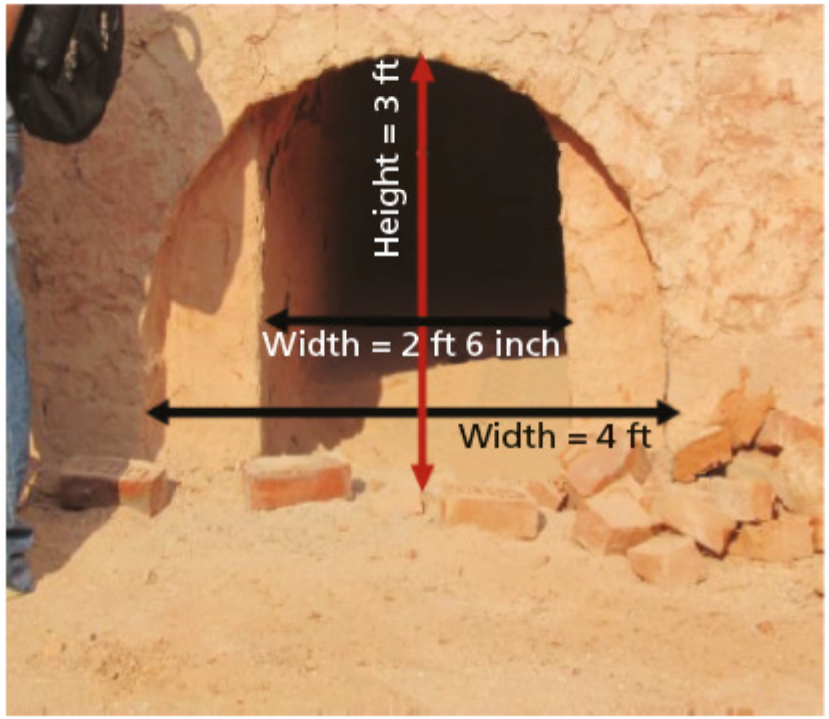
Side Nali

The cross-section of a side nali is about 70 per cent of the mail nali



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Side Nali Spacing

Side nalis are flue inlets placed at regular intervals along the length of the miyan. The spacing is defined by the length of the chamber

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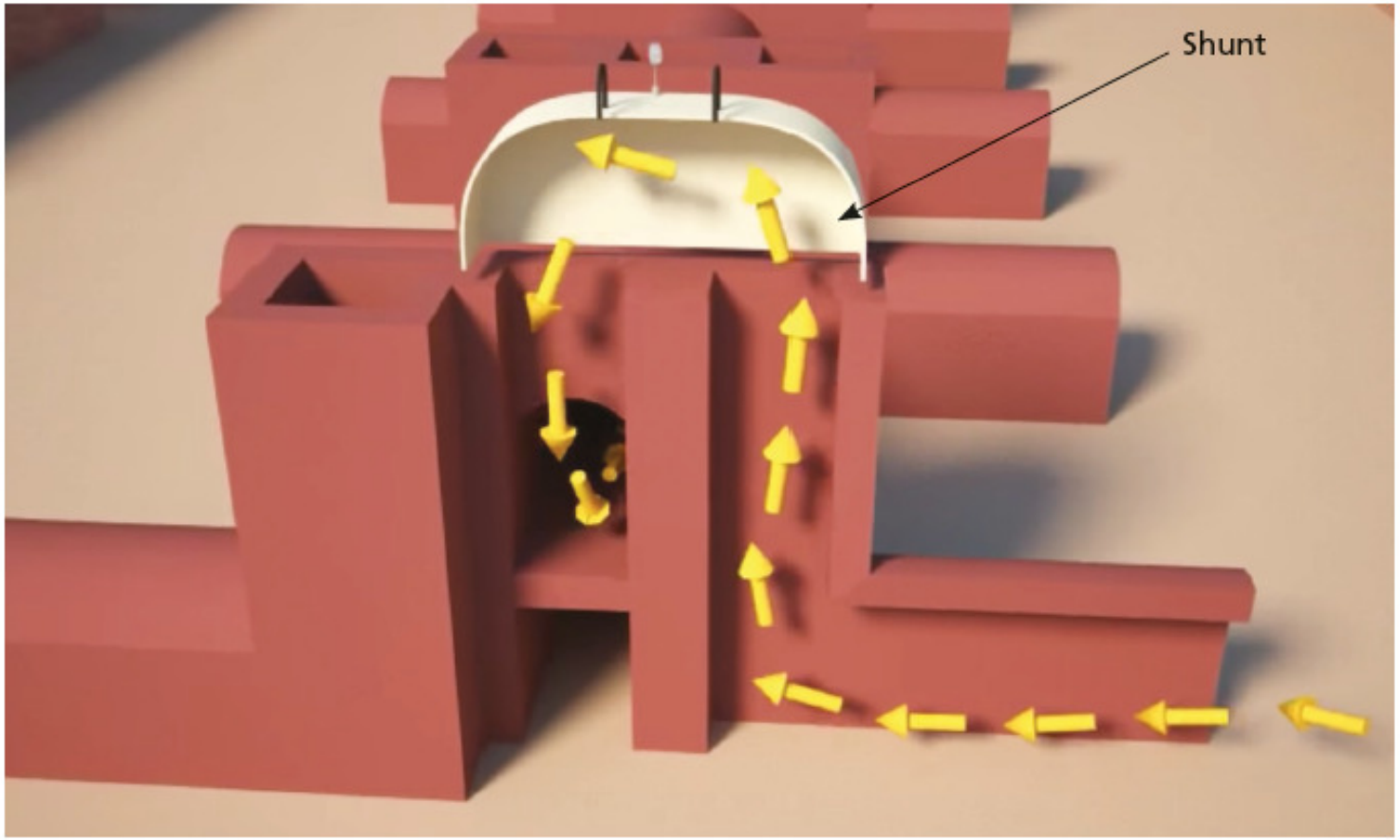
Vertical Hall or Mangal

- Vertical hall is a rectangular structure that serves as connector between the main and side nalis and the shunt.



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Vertical Hall or Mangal

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Gali Width

- The gali is a narrow section on either edge of a zigzag kiln, always narrower in width than the dug width. It is generally half of the dug width and not more than 15 – 16 feet at max

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MIYAN DIMENSION

- The length of the miyan is decided according to the number of chambers to be set on one side of the trench length

- In case the chimney is located at the center of the miyan, the width of the miyan should be able to accommodate the base of the chimney. In such cases, the width of the miyan usually varies between 18 to 30 feet.

- If, on the other hand, the chimney is located on one side of the kiln, the width of the miyan can be less (sufficient enough to accommodate the flue duct system)—about 16–18 feet.

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MIYAN DIMENSION

Dimension of a miyan;

- Miyan length = 156 feet (26 chambers) or 192ft (32 chambers) + 1 brick size
- Miyan width = 25–28 feet for natural and 18 ft for induced draft zigzag kilns
- Miyan height = 10–11 feet

- For a smaller kiln of 26 chambers, i.e., the miyan length should be 156ft (26 ft x 6ft chamber = 156ft). If a kiln has 32 chambers, miyan length should be 192ft (32 ft x 6ft chamber = 192ft)

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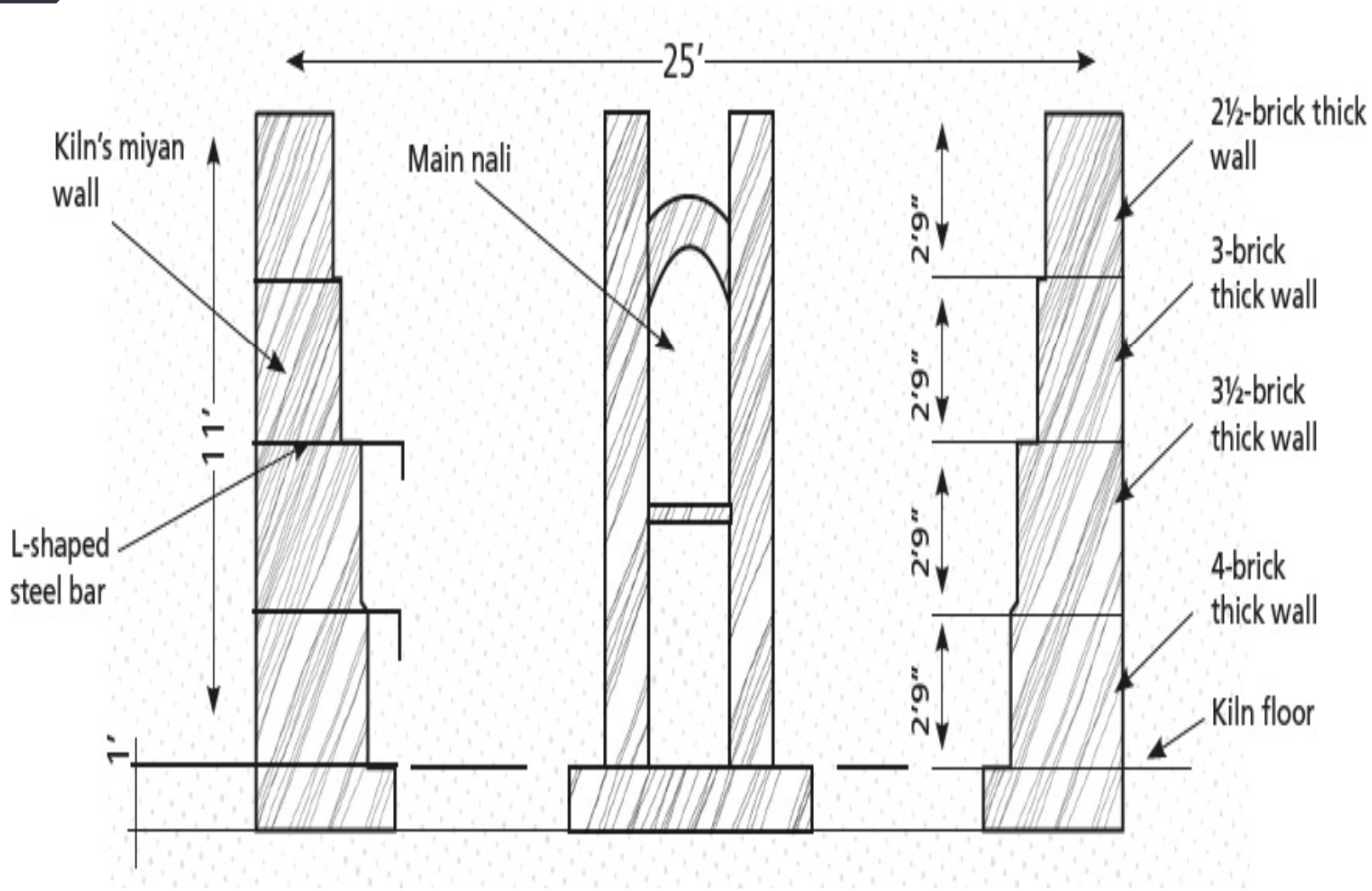
Schematic of miyan wall



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Miyan wall

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KILN'S OUTER DIMENSIONS

- **A kiln's outer dimensions can be calculated simply by adding dug width and gali width to the miyan wall's dimensions**

- **Length of kiln (excluding outer wall thickness) = Length of miyan + 2 x gali width**

  for example = 156 + 2 x 15 = 186 ft (for zigzag kilns with 26 chambers and 15 ft gali)

- **Breadth of kiln (excluding outer wall thickness) = Width of miyan + 2 x dug width**

  for example = 25 + 2 x 33 = 91 ft (for zigzag kilns with 33 ft dug width)

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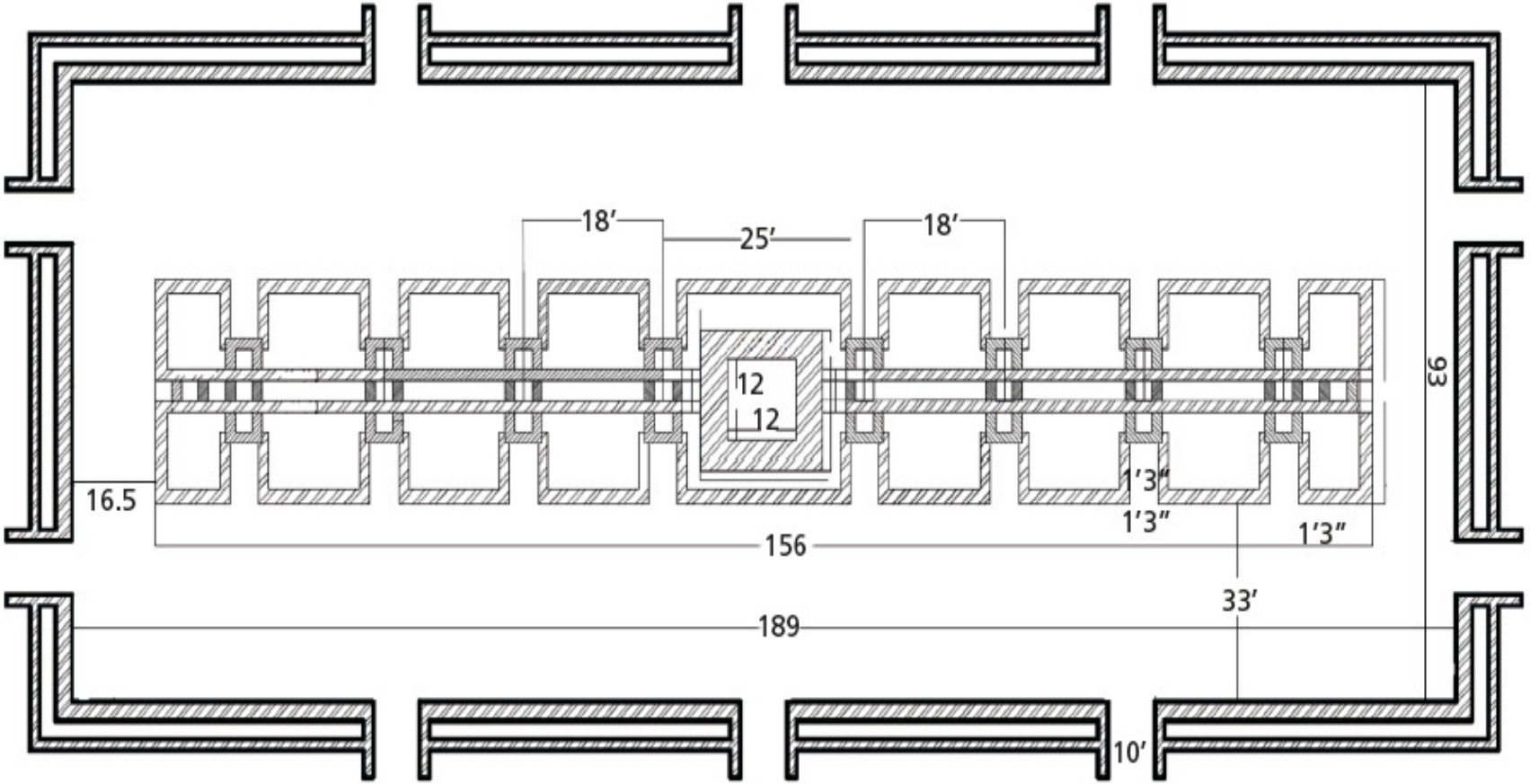
KILN'S OUTER DIMENSIONS



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KILN WALLS

The outer wall and the miyan wall are the two key kiln walls. Since there is a lot of workers' movement around the walls, they need to be strong and durable.

Miyan wall has already been discussed earlier

Outer Wall Design

Generally, the outer wall is a double brick wall plastered with mud. The space between the walls is filled with mud and ash, for insulation. A three inch inclination is maintained from the bottom to the top of the outer on the outside of the kiln.

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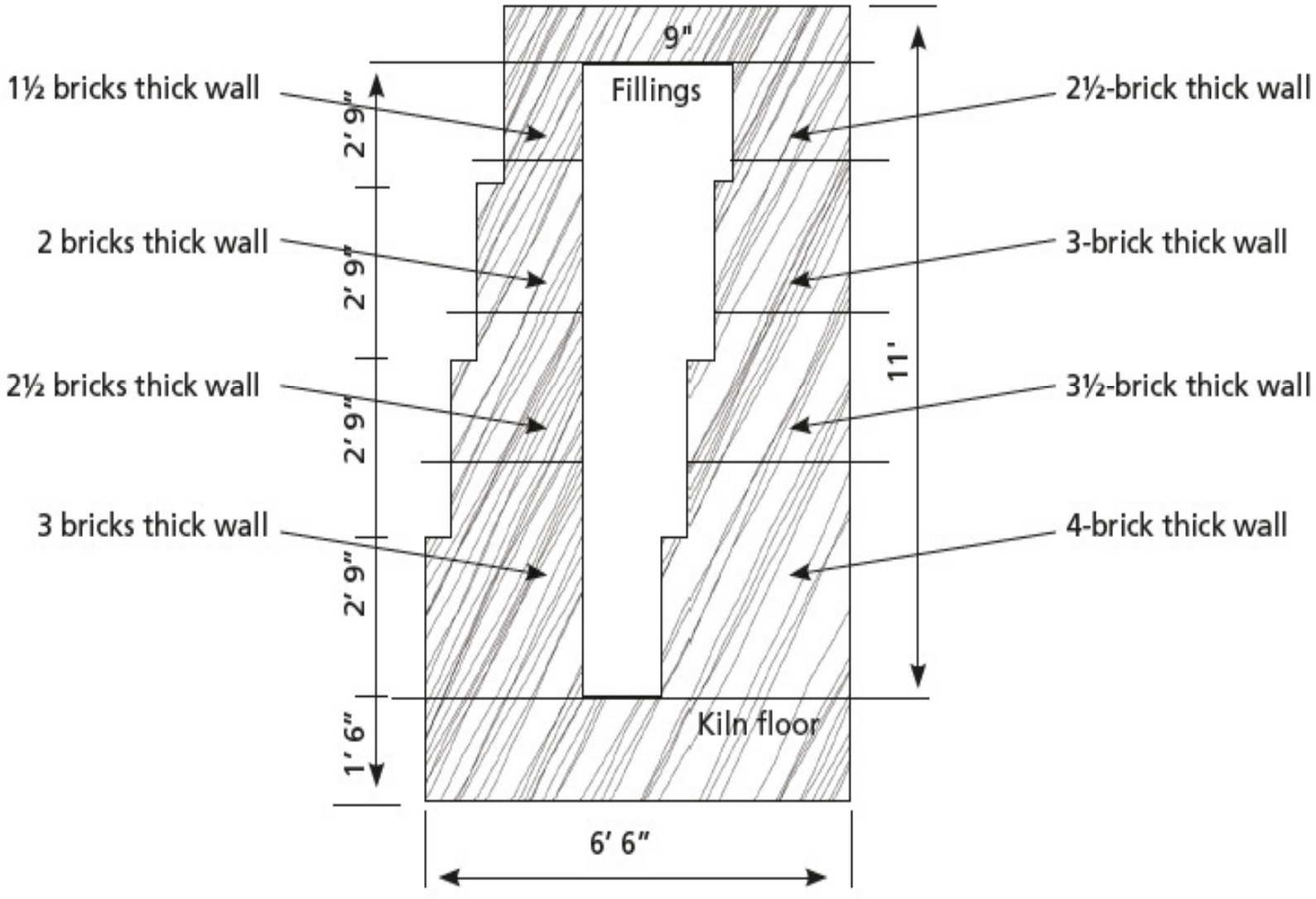
Cross-section of the outer wall



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Outer wall of the kiln

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WICKET GATE or DWARI

Wicket gates are provided in the outer wall of the kiln for transportation of bricks in and out of the kiln. There is no consistent design methodology to define size, positioning and number of wicket gates.

The following considerations must be taken into account while designing a wicker gate:

- Heat loss must be minimized;
- It should be easy to transport green bricks into and fired bricks out of the kiln;
- It should be easy and to transport green bricks into the dug efficiently using any mode of transport, either human, animal, electric cars or trucks.

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WICKET GATE or DWARI

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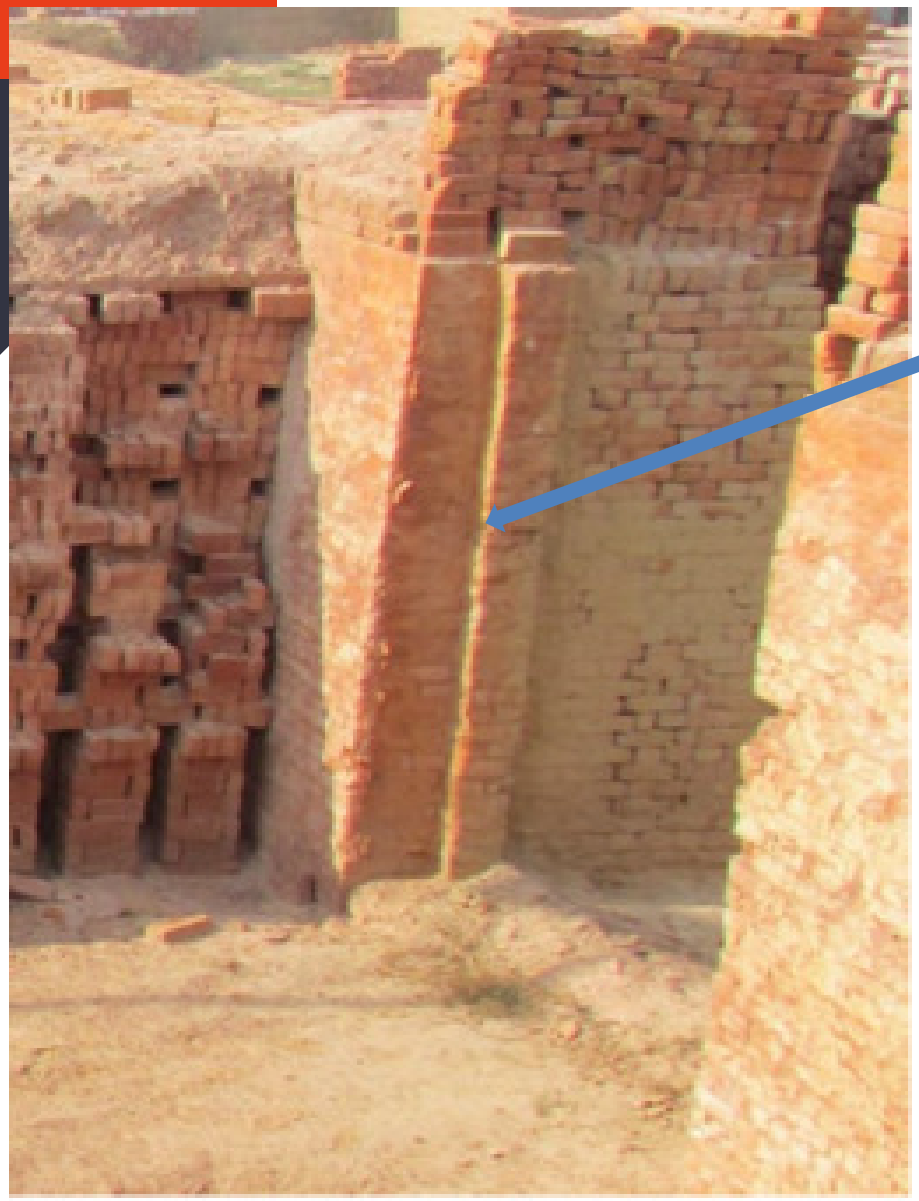
WICKET GATE or DWARI



Space left for filling ash for better insulation

Two 18 inch walls are constructed and before and one after this space

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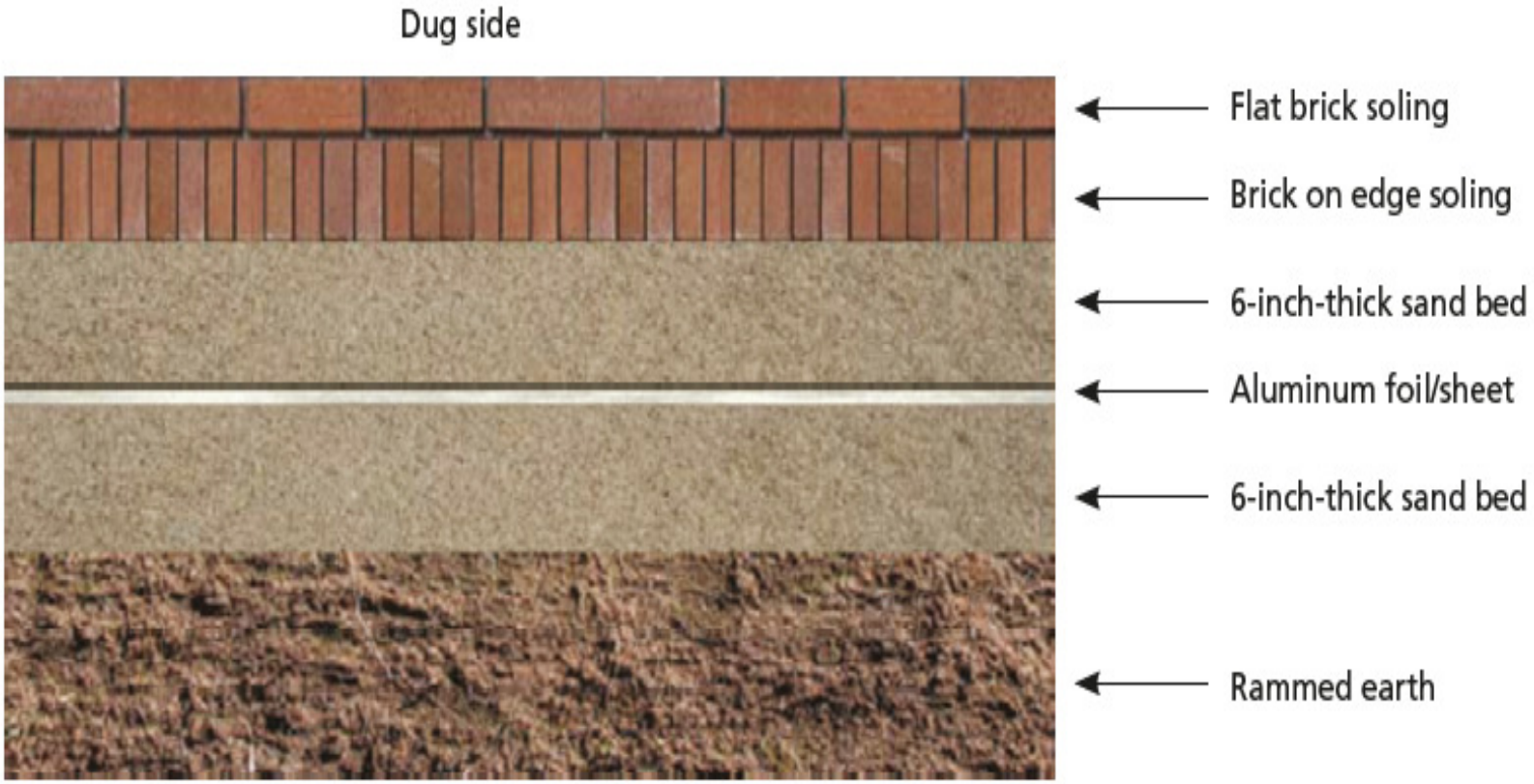
Kiln floor design



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Chimney

- The chimney is the most important and costly section of a kiln structure. Hence, chimney design is of prime concern for all kiln owners

- In retrofitting of existing kiln into High Draft zig zag kiln same chimney can be used but for stack monitoring, a port hole and a proper platform for placing the monitoring instrument should be provided

- In Natural draft zig zag kiln the chimney is responsible for creating the draft and therefore the height of the chimney is decided depending upon the production capacity

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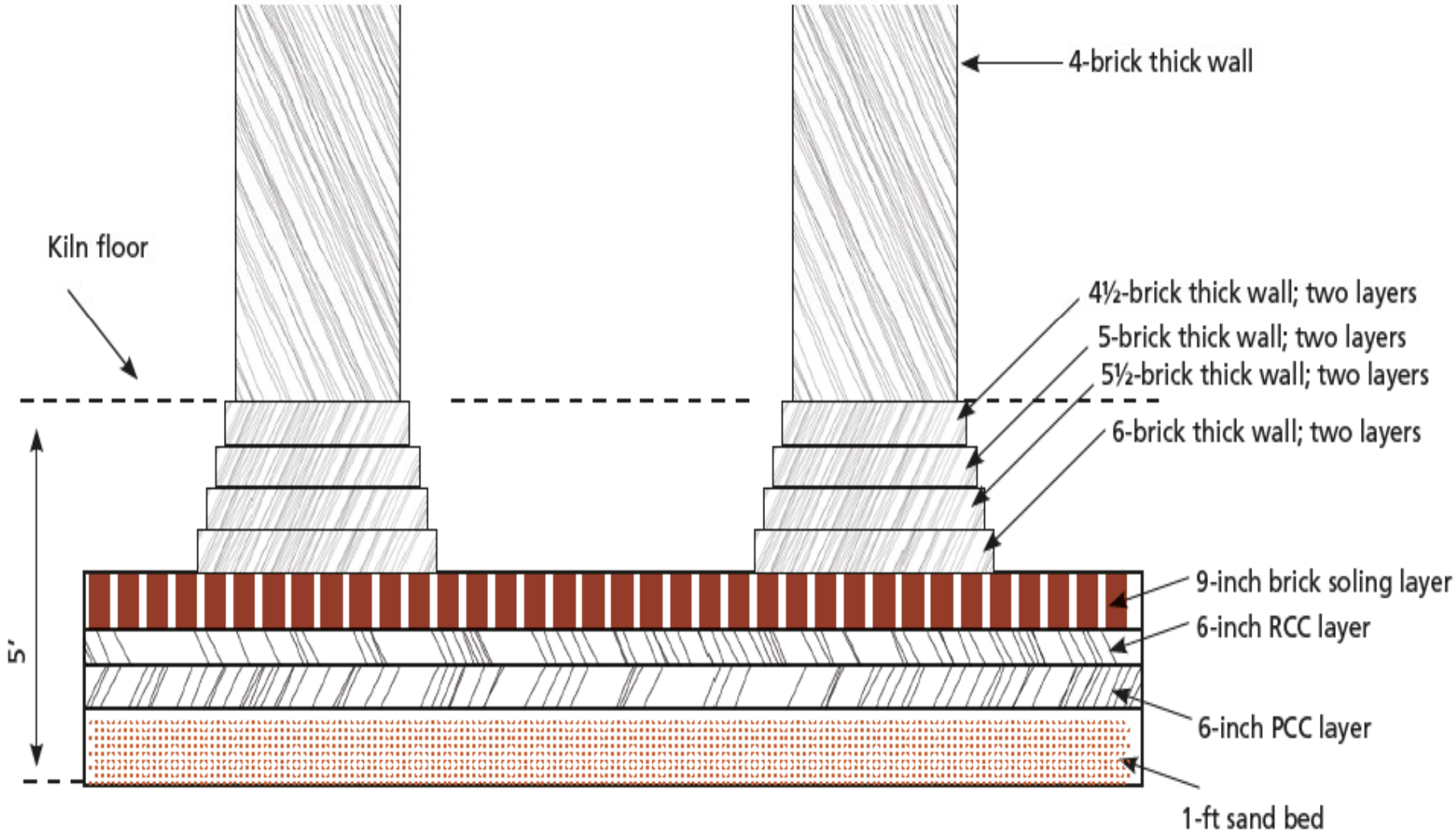
A typical Schematic diagram of a chimney base



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Apparatus Required

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Timeline For Retrofitting

- The complete process of retrofitting AN INDUCED DRAFT KILN WHERE SAME CHIMNEY IS USED takes around 50-60 days, after which the kiln is ready for stacking and firing the next batch;

- Conversion to a NATURAL DRAFT KILN takes approximately 30 days extra, since the chimney needs to be dismantled and reconstructed; here the entire process of conversion takes around 80-90 days

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Techno-economics of retrofitting a FCBTK into zigzag brick kilns

	Initial FCBTK	Retrofitted zigzag
Annual production	40 lakh	40 lakh
Coal consumption per lakh bricks	16 tonne	12 tonne
Class I bricks produced (percentage)	55–60	80–90 per cent

	Induced zigzag	Natural zigzag
BREAK UP OF THE COST		
Labour cost	Rs 5.5–7.5 lakh	Rs 5.5–7.5 lakh
Material (other than brick)	Rs 1–1.5 lakh	Rs 1–1.5 lakh
Equipment	Rs 2–2.5 lakh	Rs 2–2.5 lakh
Fan (with engine)	Rs 3–4 lakh	Not applicable
Chimney	Not applicable (same chimney can be used)	Rs 8–10 lakh
Bricks @ Rs 3/brick	Rs 6–9 lakh (for additional 2–3 lakh bricks)	Rs 9–12 lakh (for additional 3–4 lakh bricks)
Total	Rs 17.5–24.5 lakh	Rs 25.5–38.5 lakh

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BENEFITS

Annual coal savings 160 tonne @ Rs 10,000 per tonne	Rs 16 lakh	Rs 16 lakh
Increase in revenue due to higher number good quality bricks (considering 8 lakh additional Class-I bricks annually) @ Rs 1 per brick	Rs 8 lakh	Rs 8 lakh
Annual expenditure on operation and maintenance of fan	Rs 2.5 lakh	
Total annual savings	Rs (16 + 8 - 2.5) = 21.5 lakh	Rs (16 + 8) = 24 lakh
Simple payback period	One brick season	One–two brick seasons

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Thank you

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