

Comparative Analysis between Ordinary Brick Masonry and Cavity Wall

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Abstract - Simply stated, a cavity wall is two walls of masonry, separated by a cavity of varying dimension. The masonry walls may consist of solid brick, structural clay tile, or concrete masonry units and are bonded together with masonry ties. Cavity walls are not new, they have been observed in ancient Greek and Roman structures. At the Greco Roman town of Pergamum, on the hills overlooking the Turkish town of Bergama, a stone wall of cavity type construction still exists. All materials required are usually available locally, which eliminates costly shipping charges and untimely postponements. Cavity walls are energy efficient when considering the life cycle cost of a building. Description of the properties of cavity walls, including structural properties, water penetration resistance, fire resistance, and thermal and sound transmission properties are included. Recommendations for cavities, flashing, expansion joints, ties and other related subjects are covered. Also covered plan of normal masonry wall & cavity masonry wall and their estimation and costing.

Index Terms - Cavity wall, masonry work, brick masonry, cost estimation.

I. INTRODUCTION

A cavity or 'hollow' wall consists of two masonry leaves tied together but separated by a continuous airspace. The outer leaf acts as a 'protective skin' against the elements, principally driving rain. It works in conjunction with the inner leaf which serves as a dry construction to carry the interior finishes. The two leaves need to be tied together for structural stability and to help carry the loads imposed on them by upper floors and the roof. The cavity serves to keep the two leaves apart, preventing damp from passing through from the outside to the inside of the wall. The cavity can therefore protect any woodwork or other decorative linings in contact with the inner leaf from damp and decay. It also allows for the evaporation of any condensation or rainwater which penetrates the outer leaf and ensures a more even temperature inside the building.

The efficiency of cavity walls makes them ideal for use when constructing houses or buildings in colder climates. Cavity walls have a heat-flow rate that is 50 percent that of a solid wall. Loss of heat can be reduced greatly by the cavity, which results in lower heating bills while being less detrimental to the environment.

Advantages of Cavity Wall over Solid Masonry

- Possible reduction in the amount of masonry used in construction,
- Improved thermal insulation is obtained from them.
- Protection against rain penetration.

Various journal papers were studied for the cavity wall like Rodrigues, et al [1], H. Hens, et al [2], A. Bekkouche, et al [3], Achilles N et al [4], Kamble A, et al [5], Arsenovic M, et al [6], Hens, H et al [7], Newman, A et al [8], Standaert P et al [12], among a very large number of researchers. Furthermore various case studies were also studied of many researchers. For example, Northern Ireland's housing colony, Solid Wall Insulation in Scotland, etc.

The main purpose of this study is to study about cavity masonry wall, benefit of cavity wall, application and properties of cavity masonry wall, comparison of normal masonry wall and cavity masonry wall for selected residential plan.

II. PROPERTIES OF CAVITY WALLS

• Structural Properties

Properly designed, detailed and constructed cavity walls may be used in any building requiring load bearing or non-load bearing walls. The increased flexibility by the separation of the wall and the use of metal ties permits more freedom from differential movement between the walls. The structural behaviour of cavity walls is complex because of the interaction of the wall, ties and support conditions. Typically, the inner wall of a cavity wall is designed to support the weight of floors, roofs and live loads. The outer wall is mainly non-load bearing.

• Resistance to Moisture Penetration

One of the major functions of an exterior wall is to resist moisture penetration. A brick masonry cavity wall, properly designed and built, is virtually resistant to water penetration through the entire wall assembly. A cavity wall is designed as a drainage wall

system, so that any moisture which does penetrate the exterior wall will run down the back face of the exterior wall to the bottom of the cavity where it is diverted to the outside by flashing and weep holes.

- **Rain Screen Walls**

Cavity walls can also be designed as pressure-equalized rain screen walls. This wall system provides compartmented air spaces with vents at the top and bottom of the cavity allowing wind pressures to equalize between the cavity and the exterior. In theory, the outer wall is essentially an open rain screen that eliminates water penetration due to air pressure differences. Although pressure-equalized rain screen walls can provide increased resistance to water penetration, they are more difficult to design, detail and construct. They are typically used in projects located in areas which receive high volumes of wind-driven rain and when resistance to water penetration is of prime concern.

- **Condensation**

Although moisture penetration due to wind-driven rain may be a major concern, condensation may also be a problem in certain climates and occupancies. Differences in humidity between inside and outside air will cause vapor flow within the wall and, unless controlled, this vapor may condense within the wall under certain temperature conditions. This condensation may contribute to efflorescence when soluble salts are present, corrosion of metal ties or disintegration of the masonry units.

- **Thermal Properties**

Heat losses and heat gains through masonry walls can be minimized by the use of cavity wall construction. The separation of the exterior and interior wall by the cavity eliminates or reduces thermal bridging and allows a large amount of heat to be absorbed and dissipated in the outer wall and cavity before reaching the inner wall and the building interior.

- **Thermal Mass**

Brick masonry exhibits superior thermal mass, that is, the ability to store and slowly release heat at a later time. These properties help shift the peak heating or cooling loads to off-peak times and reduce the peak temperatures. Passive solar design can be used in conjunction with cavity wall construction to take full advantage of masonry's thermal mass properties. Solar design techniques, such as the use of building orientation, day lighting and thermal mass, can provide both comfort and energy savings for the owner and occupants.

- **Fire Resistance**

Fire resistance ratings of brick masonry cavity walls range from 2 to 4 hr, depending upon the wall thickness and other factors (see Table 4). Due to their high fire resistance properties, brick walls make excellent fire walls or building separation walls for compartmentation in buildings.

- **Sound Transmission**

Resistance to transmission of sound in masonry construction is accomplished in two ways: the use of heavy massive walls or the use of discontinuous construction. The cavity wall employs both techniques, i.e., the massiveness of the two masonry wall plus the partial discontinuity of the cavity. In cavity wall construction, the air space provides a partial isolation of the two walls. Sound on one side of a cavity wall causes vibration of a wall. Because of the separation and cushioning effect of the air space and the massiveness of the masonry, the vibration is dampened and greatly reduced. A 10-in. (250 mm) brick cavity wall with brick backing has a Sound Transmission Class (STC) rating of 50, which is usually sufficient for substantially reducing typical outside noises entering the building through the wall.

III. MATERIALS

Cavity walls do not require special masonry units. Conventional ones are employed although metallic instead of bonding units tie the masonry together. The outer part of the cavity wall is usually brick masonry. The inner wall may also be of brickwork, but it is often constructed of structural clay tile, concrete blocks, or plain or reinforced concrete.

In this cavity wall construction Indian Standard bricks (19cm X 19cm X 9cm) are used. Cement used of 43 grade in masonry wall as well as cavity wall construction materials. Fine river bed sand obtained from Vyara, Gujarat, India is used as a fine aggregate. Using above mentioned materials is used in cement mortar of 1:6.

During construction of a cavity wall the inner and outer parts are anchored by metal ties laid in the horizontal mortar joints. They are arranged in a definite pattern. It is essential that the air space be kept continuous and not bridged by mortar or other material that will allow water to pass across the cavity. In this work S-type wall ties (Fig.1) are provided.



Figure1. S-type wall ties

IV. ANALYSIS AND RESULT

This section summarizes the methodology adopted in this study. A simple ground floor plan of residential is selected as shown in Fig. 2. Estimation for construction work and its rate analysis is done using standard methods. Around the structure cavity wall is constructed and its analysis for material estimation for different components of resident and rate analysis is done.

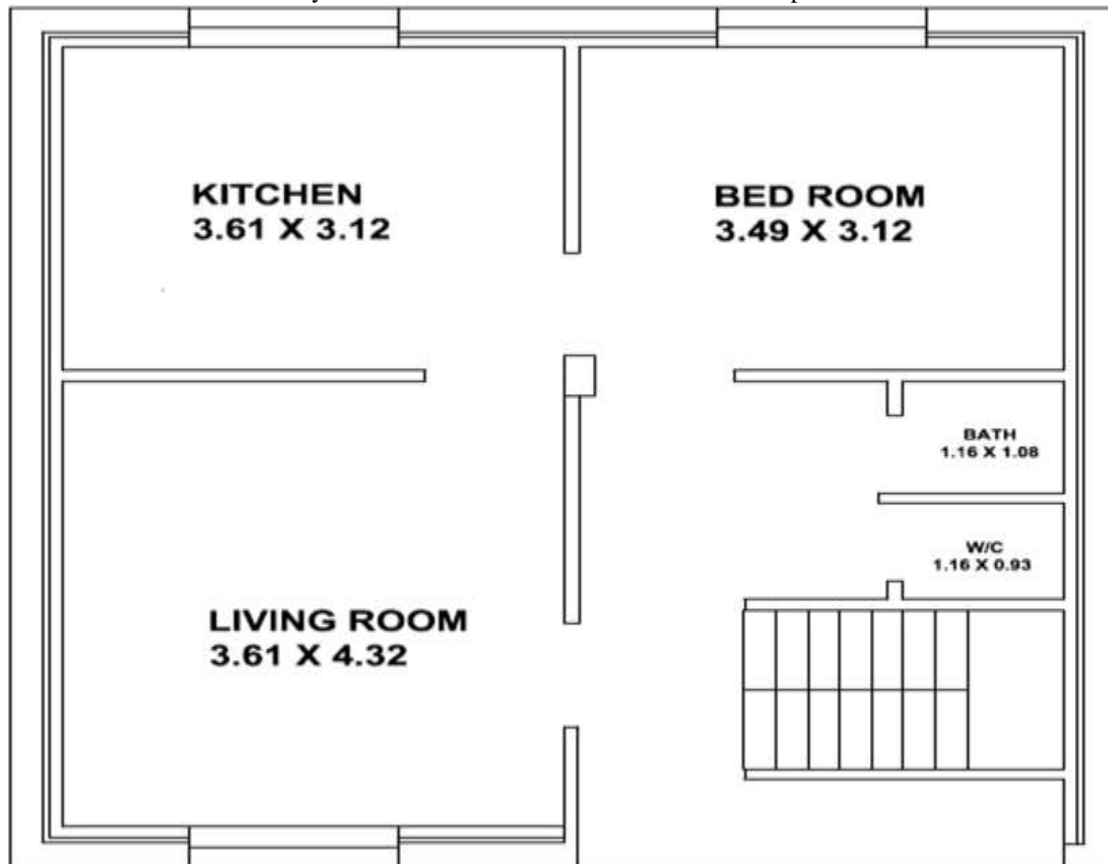


Figure 2. Cavity wall masonry plan

- **Quantity estimation and Rate analysis**

Estimation for normal masonry wall plan is given in table 1. For quantity estimation of selected residential plan long wall – short wall method is used. After obtaining estimation of material quantity rate analysis for particular construction is done. Rate analysis for different work is shown in table 2.

Table 1 Quantity estimation for normal masonry wall

QUANTITY SHEET							
NAME OF WORK :-NORMAL MASONRY WALL							
Sr. No.	DESCRIPTION	NO.	LENGTH (m)	BREDTH (m)	HEIGHT (m)	QTY	TOTAL QTY.
1	Brick Masonry Work						
	Long wall (L)	2	8.3	0.23	3	13.53	
	L 1	1	8.3	0.1	3	2.43	
	L 2	1	2.32	0.1	3	0.70	
						16.66 m ³	
	Short wall (H)	2	3.75	0.23	3	5.18	
	H 1	1	3.75	0.1	3	1.13	
	H 2	1	3.64	0.23	3	2.51	
	H 3	3	3.5	0.1	3	3.15	
	H 4	1	1.16	0.1	3	0.35	
						12.32 m ³	

							28.98 m ³	
2	Deduction							
	Doors							
	D1	4	1	0.1	2.1	0.84		
	D2	2	0.75	0.1	2.1	0.32		
	Opening	2	1.19	0.1	3	0.71		
	Windows	3	1.5	0.23	1.4	1.45		
						3.32 m ³		
							3.32 m ³	
		Total Brick Masonry = 28.98 - 3.32 m³						
		= 25.66 m³						

Table 2. Rate analysis for normal brick masonry wall C.M. 1:6

RATE ANALYSIS SHEET						
NAME OF WORK :- NORMAL BRICK MASONRY WALL C.M. 1:6						
Sr. No.	Particulars	Quantity/ Number	Rate Rs	Per.	Amount	
1	Materials					
	Bricks					
	(19 CM X 9 CM X 9 CM)	12830 Nos.	5	1	64150.00	
	Cement	35 beg	300	beg	10500.00	
	Sand	7.26 m ³	800	m ³	5808.00	
	Sundries				100.00	
			Material cost Rs. 80558.00			
2	Labour					
	Mistry	0.5	500	day	250.00	
	Mason	7	800	day	5600.00	
	Male coolie	7	250	day	1750.00	
	Female coolie	7	200	day	1400.00	
	Bhistie	2	250	day	500.00	
	Sundries				100	
			Labour cost Rs. 9600			
	Material + Labour cost Rs. 90158.00					
	Add 1.5% water charges Rs. 1352.37					
	Add 10% contractors profit Rs. 9015.80					
	Rate for 25.66 m³ Rs. 100526					
	Number of bricks for 25.66 m³ of brick work :-					
		25.66 / (0.20 X 0.10 X 0.10)				
		12830				

Mortar required for 25.66 m ³ of brick work.			
Materials for 1:6 C.M. brick work.			
		Volume of dry mortar = 25.66X0.33 = 8.46 m ³	
		Cement:- (1/7)X8.46 =(8.46/0.035)=35 bag	
		Sand:- (6/7)X8.46 = 7.26 m ³	

Table 3. Quantity estimation for Painting work

QUANTITY SHEET							
NAME OF WORK :-NORMAL MASONRY WALL							
Sr. No.	DESCRIPTION	NO.	LENGTH (m)	BREDTH (m)	HEIGHT (m)	QTY	TOTAL QTY.
	Painting work						
1	Kitchen	2	3.61		3	21.66	
		2	3.12		3	18.72	
2	Bed Room	2	3.49		3	20.94	
		2	3.12		3	18.72	
3	Living Room	2	3.61		3	21.66	
		2	4.32		3	28.32	
4	Opening	2	2.16		3	12.96	
		2	2.12		3	12.72	
5	Stair	2	3.65		3	21.90	
		2	1.74		3	10.44	
6	Varandah	1	3.5		3	10.50	
		2	0.84		3	5.04	
						203.58 m ²	
	Deduction						
	Doors						
	D1	4	1		2.1	8.40	
	D2	2	0.75		2.1	3.15	
	Opening	2	1.19		3	7.14	
	Windows	3	1.5		1.4	6.30	
						24.99 m ²	
							178.59 m ²
	Total Painting Work is 178.59 m ²					1.58	
	= 1922.4 Sq. ft.						
	=1922.4 X 17						
	=32680 Rs.						

Quantity estimation for Plaster of Paris as per painting work for normal masonry wall which is **1922.4 Sq. ft** and its cost is **14 Rs. per Sq.ft. = 1922.4 X 14 = 26913 Rs.**

Table 4. Quantity estimation for cavity masonry wall

QUANTITY SHEET								
NAME OF WORK :- CAVITY MASONRY WALL								
Sr. No.	DESCRIPTION	NO.	LENGTH (m)	BREDTH (m)	HEIGHT (m)	QTY	TOTAL QTY.	
1	Brick Masonry Work							
	Long wall cavity (L)	2	8.3	0.23	3	13.53		
	L 1	1	8.3	0.1	3	2.43		
	L 2	1	2.32	0.1	3	0.70		
	Long cavity wall (L)	2	7.74	0.1	3	4.64		
						21.30 m ³		
	Short wall (H)	2	3.75	0.23	3	5.18		
	H 1	1	3.75	0.1	3	1.13		
	H 2	1	3.64	0.23	3	2.51		
	H 3	3	3.5	0.1	3	3.15		
	H 4	1	1.16	0.1	3	0.35		
	Short cavity wall (H)	2	3.61	0.1	3	2.17		
	H 2	1	3.49	0.1	3	1.05		
						15.54 m ³		
							36.84 m ³	
2	Deduction							
	Doors							
	D1	4	1	0.1	2.1	0.84		
	D2	2	0.75	0.1	2.1	0.32		
	Opening	2	1.19	0.1	3	0.71		
	Windows	3	1.5	0.23	1.4	1.45		
	Deduction cavity wall							
	Windows	3	1.5	0.1	1.4	0.63		
						3.95 m ³		
							3.95 m ³	
			Total brick masonry = 36.84 - 3.95 m ³					
			= 32.89 m ³					

Table 5. Rate analysis for cavity masonry wall C.M. 1:6

RATE ANALYSIS SHEET						
NAME OF WORK :- CAVITY MASONRY WALL C.M. 1:6						
Sr. No.	Particulars	Quantity/ Number	Rate Rs.	Per.	Amount	
1	Materials					
	Bricks					

	(19 CM X 9 CM X 9 CM)	16445 Nos.	5	1	82225.00
	Cement	45 beg	300	beg	13500.00
	Sand	9.3 m ³	800	m ³	7440.00
	Wall ties	100 Nos.	60	Nos.	6000.00
	Sundries				100.00
			Material cost Rs.		109265
2	Labour				
	Mistry	0.5	500	day	250.00
	Mason	7	800	day	5600.00
	Male coolie	7	250	day	1750.00
	Female coolie	7	200	day	1400.00
	Bhistie	2	250	day	500.00
	Sundries				100
			Labour cost Rs.		9600
	Material + Labour cost Rs. 118865				
	Add 1.5% water charges Rs. 1782.97				
	Add 10% contractors profit Rs. 11886.50				
	Rate for 25.66 m ³ Rs.132534.47				
	Number of bricks for 32.89 m ³ of brick work :-				
	$32.89 / (0.20 \times 0.10 \times 0.10)$				
	16445 Nos.				
	Mortar required for 32.89 m ³ of brick work.				
	Materials for 1:6 C.M. brick work.				
	Volume of dry mortar = $32.89 \times 0.33 = 10.85 \text{ m}^3$				
	Cement:- $(1/7) \times 10.85 = (8.46/0.035) = 45 \text{ bag}$				
	Sand:- $(6/7) \times 10.85 = 9.3 \text{ m}^3$				

Table 6. Quantity Estimation for Painting of cavity masonry wall C.M. 1:6

QUANTITY SHEET							
NAME OF WORK :-CAVITY MASONRY WALL (PAINTING)							
Sr. No.	DESCRIPTION	NO.	LENGTH (m)	BREDTH (m)	HEIGHT (m)	QTY	TOTAL QTY.
	Painting work						
1	Kitchen	2	3.76		3	22.56	
		2	3.27		3	19.62	
2	Bed Room	2	3.64		3	21.84	
		2	3.27		3	19.62	
3	Living Room	2	3.76		3	22.56	
		2	4.47		3	26.82	
4	Opening	2	2.31		3	13.86	
		2	2.12		3	12.72	

5	Stair	2	3.65	3	21.90	
		2	1.74	3	10.44	
6	Varandah	1	3.65	3	10.95	
		2	0.84	3	5.04	
					207.93 m ²	
	Deduction					
	Doors					
	D1	4	1	2.1	8.40	
	D2	2	0.75	2.1	3.15	
	Opening	2	1.19	3	7.14	
	Windows	3	1.5	1.4	6.30	
					24.99 m ²	
						182.94 m ²
	Total Painting Work is 182.94 m²					
					= 2001.44 Sq. ft.	
					= 2001.44 X 17	
					= 34025 Rs.	

Quantity estimation for Plaster of Paris as per painting work for Cavity wall which is **2001.44 Sq. ft.** and its cost is **14 Rs. per Sq.ft. = 2001.44 X 14 = 28020 Rs.**

- Summary of results**

Construction cost for Normal masonry and Cavity masonry wall.

Normal masonry wall

Total Qty. = 25.66 m³

Construction cost = 100526 Rs.

Cavity Masonry wall Total Qty. = 32.89 m³
Construction cost = 126534 Rs.

For 1m³ wall ties require

For 32.89m³ 100 wall ties require

Cost of 1 wall ties is 60 Rs.

Cost of wall tie = 60*100 = 6000 RS.

Total cost = 132534 Rs.

Cost of fiber glass wool per sq. meter = 100 Rs.

Cost = 32.89*100 = 3289 Rs.

Total cost = 135823 Rs.

Painting cost for 20 years Normal masonry wall and Cavity masonry wall.

Normal masonry wall for painting

Cost is 32680

Painting done at every 5 years

32680*4 = 130720 Rs.

Total Cost of Normal Masonry

Wall for Painting (20 years) = 130720 Rs.

Cavity masonry wall for painting

Cost is 34025

Painting done at every 10 years

34025*2 = 68050 Rs.

Total Cost of Cavity Masonry

Wall for Painting (20 years) = 68050 Rs.

POP cost for 20 year normal masonry & cavity masonry wall

Normal masonry wall area

= 1922.4 sq. ft.

Per sq. Fit = 14 Rs.

Cost = 14*1922.4 = 26913 Rs.

POP done at every 5 years

26913*4 = 107652 Rs.

Total Cost of Normal Masonry

Wall for 20 years = 338898 Rs.

Cavity masonry wall area

= 2001.44 sq. ft.

Per sq. Fit = 14 Rs.

Cost = 14*2001.44 = 28020 Rs.

POP done at every 10 years

28020*2 = 56040 Rs.

Total Cost of Cavity Masonry

Wall for 20 years = 259913 Rs.

COST DIFFERENCE = 78985 Rs.

V. CONCLUSIONS

- ◆ At basic level initial cost of cavity wall higher than normal wall.
- ◆ But, as per comparisons for long term cavity wall is more economical than normal masonry wall.
- ◆ It maintains the temperature inside the room and does not allow drastic changes in the room.
- ◆ In cavity wall there is no need for making conceal wiring.
- ◆ Water supply can be installed in cavity wall
- ◆ Cavity masonry wall is more fire resistance than normal masonry wall.
- ◆ We conclude that in country like India cavity wall is more effective because India being a peninsular it's more area is connected with ocean so there is a moist climatic conditions prevailing in India.
- ◆ Cavity wall can be constructed up to three floor height. We can consider as drawback of cavity wall construction.
- ◆ In this study fiber glass wool is used as insulating material for cavity wall, instead of this one can use other material like glass wool, mineral wool or cavity closer.

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