Effective use of Brick Arches, Projected Brick Arches and Brick Corbels for Reduction of Cost in Building Construction and Increase the Beauty of The Structure Along with Case-Study of Kailash Kutir

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Abstract— Shelter is amongst the three basic human needs but now-a-days, about two-third of the total Indian population does not have their own shelter. This two-third population belongs to the middle and lower income class. These people find it difficult to construct their houses at an affordable cost by using conventional construction technology. It is found in many cases that people serve their whole life constructing their own house, but fail. The mission and dream of these people can be achieved by appropriate use of cost effective and innovative construction technology. As a whole, the housing shortage of the country can be overcome within lesser funds, without compromising with the quality control and structural stability of the structure. My this work is in continuation with the paper entitled "Cost Effective and Innovative Housing Technology", presented in IJSRD Vol. 2, Issue – 6, pages 27-29. In this work I have shown the effective use of Brick Arches, Projected Brick Arches and Brick Corbels to reduce the construction cost as compared to that of RCC beams and RCC slabs.

***Key Words*:**

- **RCC:** Reinforced Cement Concrete is the combination of steel and cement concrete used in building construction.
- **Brick Arch:** An arch is a structure that spans a space and supports structure and weight above it. An arch is a pure compression form.
- **Brick Corbel:** Corbels are the projections in walls to support a structure over it. Corbels using bricks as their construction material are called as brick corbels.
- **Slab**: A large, thick, flat piece of stone or concrete, typically square or rectangular in shape.
- **Brick Masonry:** A type of construction that has units of baked clay or shale of uniform size, small enough to be placed with one hand, laid in courses with mortar joints to form walls, pillars and various structures.
- **KAILASH KUTIR**: A structure built in Village Jagdishpur Gaura, Distt. Sant Kabir Nagar, Uttar Pradesh, for testing the entire work by Ayush Srivastava.

I. Introduction

As compared to the total cost of brick masonry work, these are about 10 times much costlier. By effectively using brick arches, projected brick arches, brick corbels and simple jaali works, the need of reinforcement can be minimized at some places as well as totally avoided at other. Brick arch is much less costly, have better look and can be made in a variety of shapes and sizes.

A. Brick Arches:

An arch is a pure compression form. It can span a large area by resolving forces into compressive stresses and, in turn eliminating tensile stresses. This is sometimes referred to as arch action. As the forces in the arch are carried to the ground, the arch will push outward at the base, called thrust. As the rise, or height of the arch decreases, the outward thrust increases. In order to maintain arch action and prevent the arch from collapsing, the thrust needs to be restrained, either with internal ties, or external bracing, such as abutments. Hence, we conclude that in our entire work of brick arches, we convert the tension zone of the structure into compression zone and as per the practical knowledge; compression members are much more stable as compared to that of tension members.

Also, in our work we have not used any reinforcement in construction of brick arches, thereby reducing the material cost to a great extent as compared to that of a RCC beam. Fig.1 shows the unplastered work of one of the structure constructed by using semi-elliptical brick arches. Fig.2 shows the plastered and finished work of the same structure which depicts the beauty of the structure.

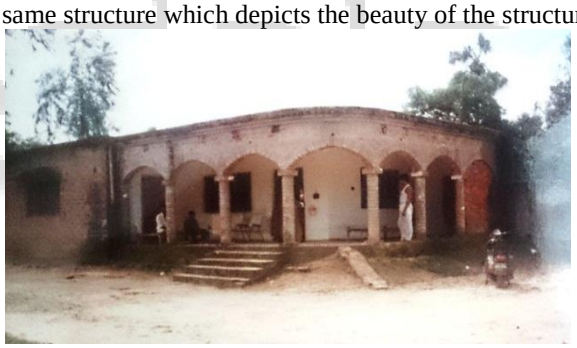

Fig. 1: Unplastered work of 'KAILASH KUTIR' built by using semi-elliptical brick arches

Fig. 2: Plastered and finished work of 'KAILASH KUTIR

Arches can be constructed in a variety of shapes and sizes but a perfectly semi-circular arch is found to transmit the entire load acting over it to the side supports. As per the needs and requirement of particular zone of the structure the shape to be provided can be chosen from a huge list. Few common shapes of brick arches are as shown in Fig.3.

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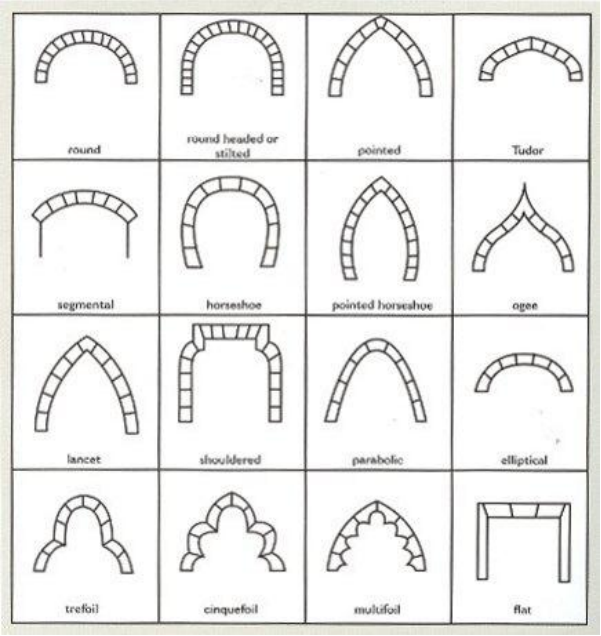

Fig. 3: Few commonly used shapes of arches

Talking about the stability of brick arches, we can say that these are stable for a number of centuries as the entire work is in compression zone and the entire load acting over these members are fully or partially transferred to the side supports (side supports may be columns or brick masonry wall).

One more area where we have used brick arches are over the ventilators and door openings. Here, instead of providing RCC lintel, we have provided curved brick arches. The main reason for this use is to replace the substantial amount of RCC work which is much more costly and heavy as compared to that of simple brick work. Fig.4 shows demonstration of brick arch over the ventilator openings.

Fig. 4: Demonstration of use of brick arch over a ventilator opening

B. Projected Brick Arch:

A simple brick arch projected outward from a wall surface is called as projected brick arch. We have used this technology to replace the lintel slabs and chhajja RCC works over the window, ventilator and door openings in the exteriors. The main work of these structures is to cover the window from top side and resist the passage of rain water to the interiors. We have used extended brick arch in place of RCC work thereby avoiding the use of reinforcement and concrete.

Fig.5 shows the demonstration of use of extended brick arch over a window opening in the building exteriors.

Fig. 5: Demonstration of use of extended brick arch over the window opening in the exterior

C. Brick Corbel:

Corbels are the projections in walls to support a structure over it. Corbels can be made in a variety of shapes and by a variety of materials, but here as far as cost efficiency is concerned, we can use simple brick masonry corbels. At some places, the cantilever beam or projection can be converted into a simply supported by the effective use of corbels. This reduces the use of reinforcement, cement and concrete thereby reducing the total cost of construction. This is highly cost effective as well as highly stable and durable because all the structural members are converted into compression zone.

Corbelling is the use of a number of brackets, in our case bricks, which project beyond the face of a wall as cantilevers. The maximum cantilevered distance is determined by the one-third rule, that is, each brick should not project more than one third of its bed length, and the maximum distance corbelled by a number of bricks should not exceed one third of the wall's width. But in our case we have taken this maximum distance as one fourth of the bed length of the brick. Fig.6 shows the demonstration of brick corbel.

Fig. 6: Demonstration of brick corbel

We can also use plastered corbel in the building interiors which not only does the supportive framework but also beautifies the interior decoration of the structure. Fig.7 shows the use of plastered and finished brick corbel in the building interior.

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Fig. 7: Use of plastered and finished brick corbel in the building interior

We have also used brick corbel to support the projected brick arches. The reason for this work is to take the entire load acting over the projected brick arch by serving as its side supports and transferring the entire load to the bearing wall. Hence the entire load, supposed to be acting on the tension member is converted into compression zone and borne by the load-bearing wall that supports the structure. Fig.8 shows the use of brick corbels under the projected brick arch.

Fig. 8: Use of brick corbels under the projected brick arch over the window openings

Effective use of brick corbels at certain places can convert the cantilever projections of slabs into simply supported. Fig.9 shows the use of brick corbels for converting the cantilever projection of building slab into simply supported which itself becomes strong and stable.

Fig. 9: Use of brick corbels for converting the cantilever projection of building slab into simply supported

D. Attractiveness of the built structure:

After the completion of entire works, including finishing works, the structure depicts its beauty and attracts the passersby towards it. Fig.10 shows the current view of 'KAILASH KUTIR' as seen by the passersby.

Fig. 10: Current view of 'KAILASH KUTIR' as seen by the passersby

II. Conclusion

By using the above mentioned technologies, about 70-80% of the total cost of construction of lintel, lintel beams, chhajja works and supportive works of a building can be saved without compromising its quality control and structural stability. Although, there is reduction in the use of costly building materials, the used materials are compiled in such a way that the structural strength and its durability increase as compared to the conventional building construction technologies. We have converted the tension members to the compression members which themselves are highly stable.

References:

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[3] Paper published in IJSRD, Vol.2, Issue 6, entitled 'Cost Effective and Innovative Housing Technology', by Ayush Srivastava

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