Journal of South Asian Research
Vol. 1, No. 1, 2023, pp. 1-12
e-ISSN: 2583-7273
URL: www.arfjournals.com
https://DOI: 10.47509/JSAR.2023.v01i01.01

THE ANALYSIS OF THE DEFORMED WALL AT DK AREA, AT MOHEN JO DARO

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Abstract: The wall of the main street of DK G Area, Mohen jo Daro partially deformed, due to the torque effects this is studied here on a lateral cross wall in the chief house. Furthermore, the resulting behaviour of the bucking wall demonstrates the significant load-bearing capacity of the structure under service conditions and its high sensitivity to imposed changes of the geometry. Although the tensile stresses exceeded the flexural strength at the vertices and the length of the wall, hence both the geometry and condition of this area are critical for the safety of the wall. The results of this study can improve the assessment and thus help in the preservation of many important walls, in the DK Area.

Keywords: Structural safety; Masonry; Conservation; Failures; Case reports. Dr. Frame 2D software

Received : 11 January 2023
Revised : 28 January 2023
Accepted : 08 February 2023
Published : 30 June 2023

TO CITE THIS ARTICLE:

Dr. Javeria Shaikh (2023). The Analysis of the Deformed Wall at DK Area, at Mohen Jo Daro, *Journal of South Asian Research,* 1: 1, pp. 1-12.

Introduction

Approximate coordinates of the site are 27ºN and 68º8´E, the climate is arid, and the average rainfall is less than 5 inches per annum. Annually these walls at Mohen jo daro experience deformations due to the ground surface subsidence movement with underground varying water table the subsoil consist of about 90 percent of water, the top 50 feet of the soil profile being relatively heavier soil[1]. Under this impact the base of the walls are disturbed which results in structural deformations and damages. On the one hand, repeated interventions have resulted in structural deterioration and on the other hand, owing to change of ownership requirements to upkeep of archaeology have become more severe.

The timber and iron, I sectioned trusses installed at the chief house, (Fig. 1) prevents the buckling at one side only. Though this intervention compromised the structural scheme of the building as, Fig. 1, causing an excessive increase of the thrusts on the lateral wall from the external side, which were previously balanced by a system of columns and roof buttresses (original 5000 years ago). In addition, the primary design was constantly transmitting loads and balancing it, hence the weight of the upper structure is usually transmitted through the lateral wall upon the pier with an offset. Today this isolated wall is not behaving similarly, but the entire load is being transmitted to the lower end of this wall, which has to fit in the narrow area of the street. The combination of these forces with the thrust of the continuity resulted in the progressive instability of the lateral wall and the formation of minor and major cracks, at the relatively weak area of the wall.

As a consequence, failure resulted from excessive horizontal displacements, and the critical crack pattern generally follows the scheme in Fig. 2 the longitudinal cracks develop at the extrados parallel to the edges. This pattern has been mainly established through inspections of damaged structures, but no information is available on crack propagation or the distribution of the loads during failure.

The aim of this paper is to study the main deformation affecting Moenjodaro Chief House wall, an archaeological site that prospered from 2350 to 1800 BC, thermal stress causing walls to lean and decay structurally.

Figure 1: The exo skeletal support (30 March, J.Shaikh 2012)

1.1. Structural Scheme

As in most walls, the end structures facade in figure five can function as the longitudinal thrust. So far as the transverse thrusts are concerned, the supporting were used initially as they are formed by more 45 degrees angled support, so their thrusts can be distributed to more supports along the wall. This type of a support system adopted originally as safe solutions in order to treat uncertainties in the performance of the upper structure. However, the upper structure is also remodelled in the early 19^{th} century, probably with plain quadripartite ribbed exo- structure. During studies, the signs of geometric instability prompted the application of external buttresses, which support the wall springing above at about 0.3 of its total height. With the thrusts of the wall stabilized, the weight of the upper structure would be transmitted to the piers through the lateral wall.

1.2. Cross support of the South Street

The support at the south room, span almost square compartments, and the height of their vertices reaches the middle of the lateral elevation as shown in Figure three. At their outer edge they are supported upon the wall and the attached responds, while the edges of the angular support along the wall rest upon the main foundation Figure three. Transverse pointed angle support mark the edge between the neighbouring bays. The diagonal ribs and the transverse wall have the same plain cross section and they spring from a low buried *foundation*, while the pockets created between the supports of the wall reach the third of the height. The wall is made of load bearing masonry, composed of long thin slabs of regular thickness.

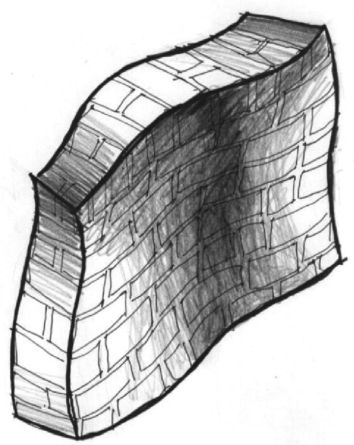

Figure 2: The deformation in a curvilinear form, since the material is tired and is bending with the load

1.3. Collapse of 2012

In 2000 the extensive decay of the wall prompted the replacement of the bricks with new over burnt bricks, hence the wall become thick. This, however, accelerated the already dangerous state of the walls, few archaeologists surveyed the fabric earlier in 1964 and, recorded in many of the walls and piers at some feet height a bulge of 5 to 8 mm toward the north, and concluded that, "the walls and pillars will incline seven or eight inches from the perpendicular that is at the greatest height'' H.J. Plenderleith 1964 UNESCO, He also observed that ''there is one of the of the wall fallen down, another just ready to drop away, several of the small columns on the Pillars come away, others fast following; the walls much bent in several places and the whole structure approaching ruin at swift pace.''

Figure 3: the view of the deformation

Depending on the types and signs of ground surface movement it makes different impact on buildings being determined (Fig. 3). At horizontal tensile deformations inclined cracks in external walls are generated which are symmetrical relative to the centre of the wall. Vertical bending and vertical shear cracks are typical of curvature of convexity, the bending cracks being typical of flexible walls which lengths exceed their heights more than thrice. Shear cracks are always generated, being more typical of two-storey and higher walls than bending crack. Under horizontal compressive deformations and curvature of concavity inclined and horizontal cracks are generated in the walls located symmetrically relative to the centre of the plan.

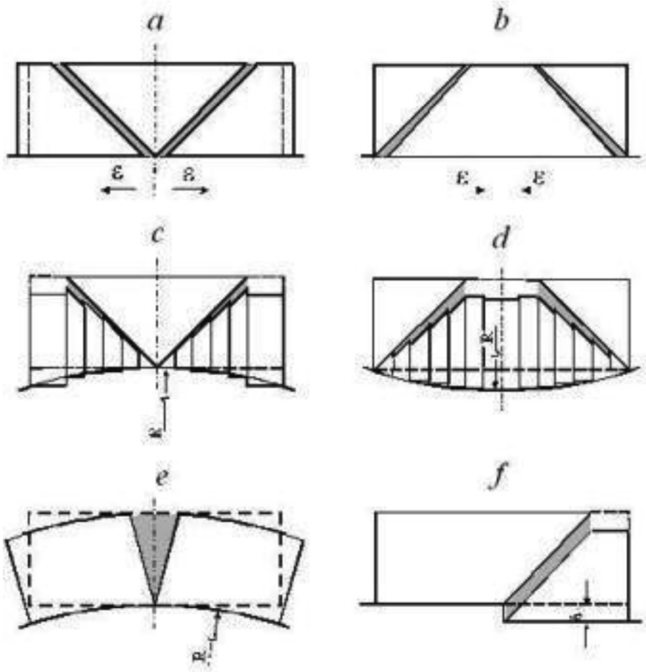

Figure 4: The generalized structural deformations of the walls induced by: a – horizontal shear due to ground surface tension; b – horizontal shear due to the ground surface compression; c – vertical shear due to the curvature of convexity; d – vertical shear due to the curvature of concavity; e – bending due to the curvature of convexity; f – vertical shear due to the bench formation

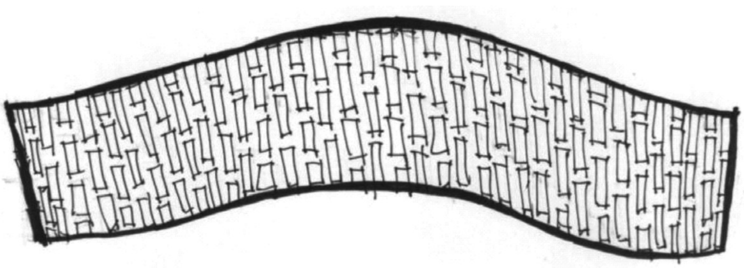

Figure: Exaggerated deformation pattern

For this purpose the following assumptions are taken. Plain deformation of a wall in longitudinal or transverse directions is considered; walls represent homogeneous deformable body; undisturbed contact of wall continuous base being deformed is assumed; principle of independence of the influencing factors shall be used: structural deformations of horizontal shear, vertical shear and wall bending induced by ground surface horizontal movement and curvature shall be determined separately in the software.

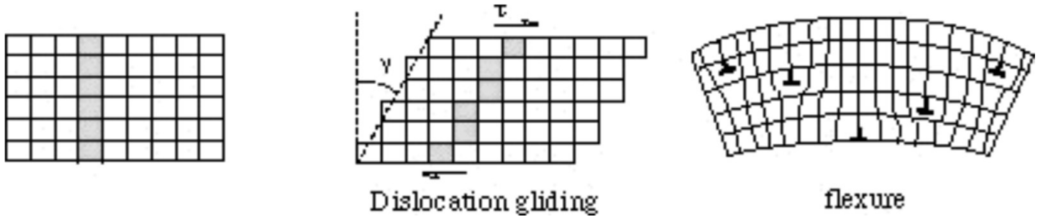

Figure 4: The deformation patterns of buildings and indexes of deformation due to the tension and the curvature of convexity

1.4. Working with Shear Walls of mohenjodaro

Dr. Frame2D includes basic real-time shear wall modelling. The image below shows an example of the Mohenjo daro typical shear wall analysis in progress. This particular display shows stress intensity and orientation, as well as the deformed configuration (although it is partially obscured in this view).

The stress display options can be categorized broadly into how stresses are displayed, and *which* elements display stress values numerically. The following subsections consider each of these in turn.

Plotting Stresses

Colour contours can display on the Frame2D software displays both magnitude and direction characteristics of a stress field. The figure below shows a close-up of a stress field.

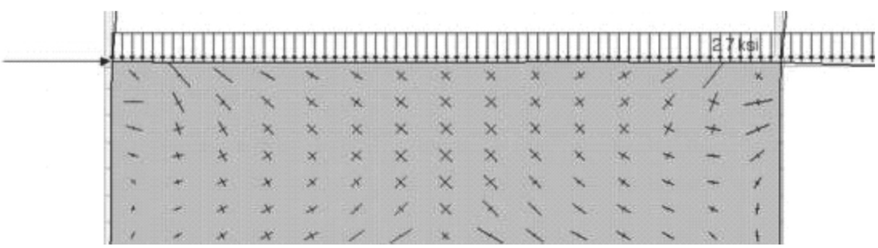

Figure 5: average stress state at different point

In the figure above, the small crosses that are drawn at each point represent the average stress state within the corresponding brick group. The crosses are oriented according to the principal directions of the stress state, and each leg of the cross is drawn with a length proportional to the corresponding principal stress. Red indicates tension, and blue indicates compression.

Figure 6: the deformation is seen in the perspective from the outer side

In the figure five, stresses are shown by plotting lines perpendicular to the maximum in-plane tensile stress direction, with the line lengths proportional to the maximum tensile stress magnitude. Such a depiction can help indicate where cracks might tend to form in materials sensitive to tension. Similarly, choosing the Maximum Shears option leads to the plot below in which the stress are aligned with the directions of maximum shear stress. This depiction can indicate yielding tendencies in ductile brick materials of the wall.

As shown below, **displacement** values for internal wall nodes can be obtained either by attaching labels in the usual manner, or by selecting them using the Select Tool. This will cause the relevant results to appear in the Results Pane (for single selection, the results can also be viewed in the Inspector Pane):

The following representative test cases illustrate the basic performance of the current wall elements: Here the simplest of all cases considered this example will highlight the boundary condition and loading differences between the current elements that is individual bricks that do not have rotational degrees of freedom due to bond. In particular, the image below shows the results obtained using a standard uni-axial loading and boundary condition configuration (P = 24 k):

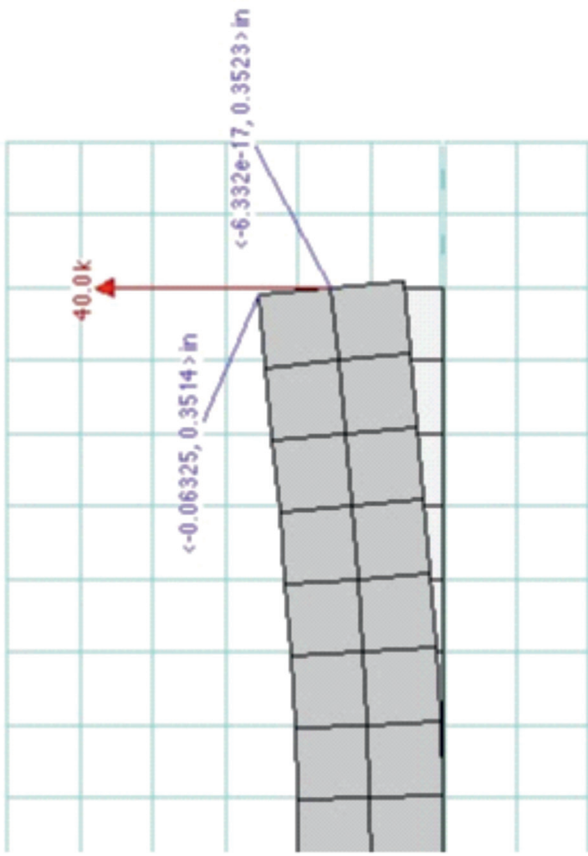

Figure 7: dead constant load of the brick, and bucking effect due to torque

The next result is the same configuration as above (fig. 7), but in this case a more refined set of boundary conditions have been applied at the wall so that the corresponding stresses can be considered.

1.5. Mechanical property

Mohen jo daro brick material has been reacting to the static and dynamic forces - compression, flexure, bending, tension, abrasion, impacts. Hence the wall has deformed due to bending moment phenomena.

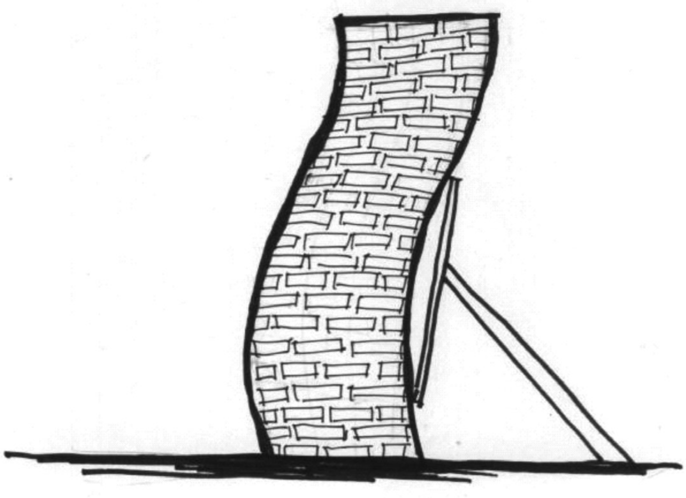

Figure 8: Exaggerated deformation pattern in the sectional view, along with the support

The following are additional limitations and issues associated with using these elements:

Distributed area loads of the bricks 40 kg per square feet, is assumed, for transversely loading walls have not been implemented as of this release. Using multiple nodal loads applied via area dragging as described above can be used as a workaround.

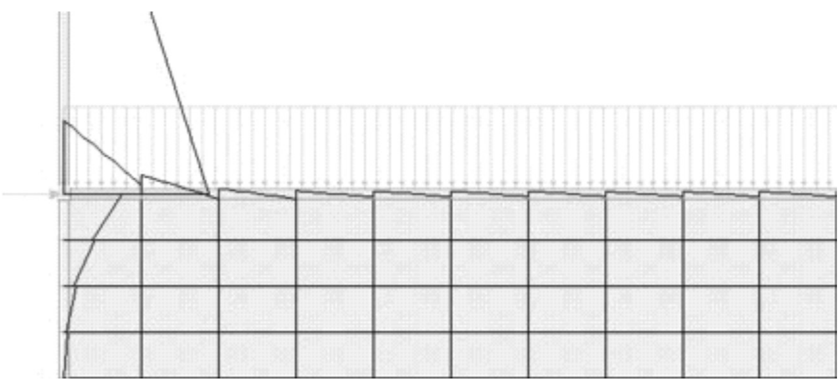

Figure 9: Moment diagram along wall-member junctions

Computer simulation of the wall deformation[2] a brief analysis is carried out on the graphical display of these brick masonry walls. That function is subsequently used for the calculations involved in the deformation evolves. From (Fig. 9) is possible to identify a zone of subtle torsion in the surface, is located around the boundary between the horizontal lines. Nevertheless, the basic programme does not include neither the diffusion equation nor the compaction due to burial (from 2000 BC). Hence is an ideal simulation of tectonic sedimentation below water level at shallow burial depths of the wall, without foundations. [3]

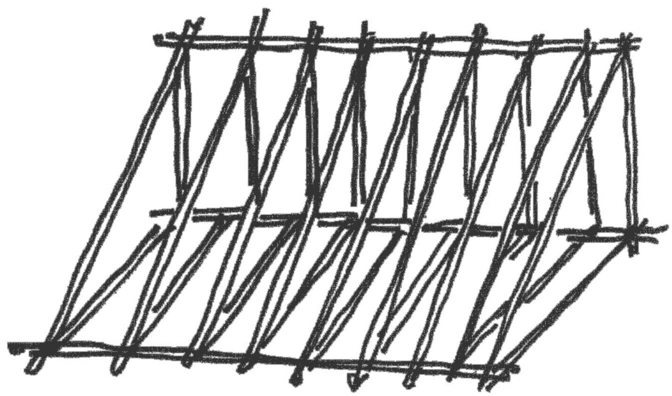

Figure 10: individual Bamboo truss, mobile design, simple low cost solution, to support the falling wall.

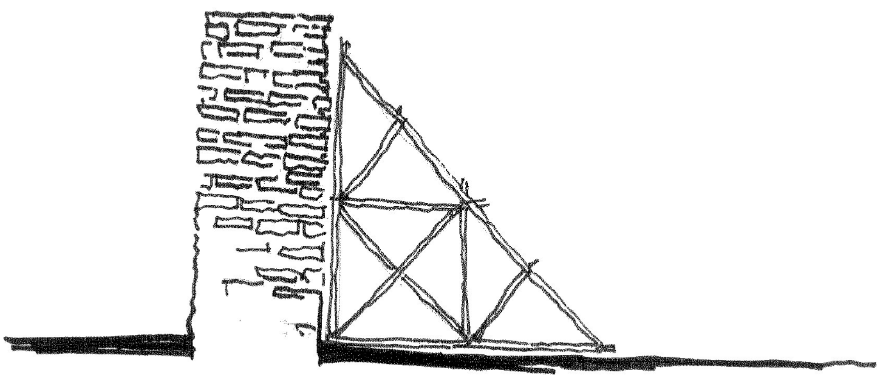

Figure 11: the instillation of the buttress to support the falling wall

1.6. Conclusion

Immediate buttress is needed, which could be easily installed, to support needed to stop the inclination, several of the supports made up of wood or bamboo, could be installed easily, by local people, using, local low cost material and sweet earth to fasten it.

Full repair is required for the 350 walls, for their structures serviceability and engineering support systems and performance properties (replacing structural elements dividing walls, strengthening though sweet earth bricks and bamboo scaffolding).

Running repair is premises appearance, uplift change without replacing its structural elements, (cladding replacement, "face-lift" refers to sweet water blasting the surface only).

1.7. Recommendation

Bamboo being a low cost material, easily repairable and removable, can be used as a support as a scaffolding and buttress, to stop the collapse of the material, since the wall is tired to hold its weigh local manufacturing of the brick which could be used to provide external removable foundation, to strengthen the unfortified wall reclining at Mohen jo daro.

Classification of deterioration reasons of building structures and materials deterioration reason Mohen jo daro wall structures and types of repair.

Notes

2. Using Dr. Frame 2D © Dr. Software, LLC 1998-2005
3. Geology Department, Royal Holloway,University of London, Egham Hill, Egham, TW20 OEX, Surrey, U.K. E-mail: mathematiker@yahoo.com

References

Hughes, R. (1995), "Moenjodaro mission report", unpublished document, UNESCO, Paris. Shaikh, K.H. and Ashfaque, S.M. (1981), Moenjodaro: A 5000-year-old Legacy, UNESCO, Paris.

Teutonico, J.M. (Ed.) (1985), International Architectural Conservation Course Laboratory Manual, ICCROM, Rome.

Goudie, A.S. (1977), "Sodium sulphate weathering and the disintegration of Moenjodaro, Pakistan", *Earth Surface Processes*, Vol. 2, pp. 75-85.

Maps are been taken from the further excavation at Mohenjo- Daro Volume II, Plats 1CXLVI (E.J.H. Mackay, 1937)

The Allowable Conditions for Undermining of Buildings at Coal Deposits O.V. Blinnikova, Engineer (UkrNIMI NAN Ukraine, Donetsk, Ukraine).

Harbaugh, J. and Bonham-Carter, G. Computer simulation in Geology. WileyInterscience. New York, 1970.

Kerr, H.G. and White, N. Application of an automatic method for determining normal fault geometries, *Journal of Structural Geology*, Volume 16, Issue 12, December 1994, Pages 1691-1709.

Waltham, D. Finite-difference modelling of hangingwall deformation. *Journal of Structural Geology*, Volume 11, Issue 4, 1989, Pages 433-437.