The Walls of Jericho and the Structural Overload Hypothesis:

An Interdisciplinary Exploration of Internal Crowd Loading and Fortification Instability at Tell es-Sultan

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Abstract

Historical and archaeological analyses of the collapse of ancient Jericho’s walls (Tell es-Sultan) have traditionally divided into two broad interpretive domains: natural destructive mechanisms such as seismic activity, or literary-theological interpretations emphasizing symbolic and ideological meaning. This paper proposes a third exploratory framework: the Jericho Structural Overload Hypothesis.

Rather than treating the fortifications exclusively as passive barriers responding to external forces, this paper examines whether internally generated human loading may have contributed to structural instability under specific behavioral and architectural conditions. Drawing upon archaeological reconstructions of Tell es-Sultan, principles of crowd behavior, and the mechanical limitations of sun-dried mudbrick fortifications, the paper explores whether synchronized crowd convergence onto elevated perimeter structures could plausibly have reduced the stability margins of the upper wall system.

The central proposal is not that the biblical narrative can be conclusively verified through engineering analysis, but rather that the described sequence of events may contain a mechanically plausible internal-loading scenario that has received relatively little interdisciplinary attention. Particular attention is given to the potential interaction between crowd concentration, eccentric live loading, sloped revetment geometry, and the low tensile strength of mudbrick superstructures.

The present analysis should therefore be understood as a hypothesis-generation exercise intended to invite further scrutiny, refinement, criticism, and testing by specialists in archaeology, structural engineering, geotechnics, crowd dynamics, and ancient Near Eastern studies.

1. Introduction and the Analytical Gap

For centuries, the account of the fall of Jericho recorded in the biblical Book of Joshua has occupied a unique place within theology, archaeology, military history, and literary studies (Joshua 6, ESV). The narrative describes the collapse of a heavily fortified city following an unusual seven-day encirclement strategy culminating in synchronized trumpet blasts and a collective shout.

Modern analysis of the Jericho narrative has generally developed within several distinct interpretive traditions:

1.1 Archaeological and Seismological Interpretations

The dominant archaeological discussion surrounding Jericho has been shaped largely by the excavations of Dame Kathleen Kenyon (Kenyon, 1957). Kenyon argued that the principal destruction of the Middle Bronze Age fortifications occurred around 1550 BCE and that the site may have been sparsely occupied or unfortified during the traditional Late Bronze Age chronology associated with Joshua (Kenyon, 1957).

Other researchers who argue for a later destruction layer have sought to align the archaeological evidence with a Late Bronze Age timeline (Wood, 1990). Within this subset of research, various analyses have explored natural structural failure mechanisms, particularly localized seismic activity associated with the active Jordan Rift Valley fault system.

1.2 Literary and Theological Interpretations

Within biblical scholarship, mainstream researchers frequently interpret the Jericho account primarily as theological literature emphasizing covenant, divine agency, sacred order, and ritual symbolism. The repeated use of the number seven — seven days, seven priests, seven trumpets, seven circuits — is widely analyzed as a literary and liturgical structuring device rather than a strictly tactical log.

1.3 Alternative Mechanistic Interpretations

Outside mainstream archaeology, some exploratory theories have attempted to explain the collapse through direct acoustic resonance generated by synchronized shouting and trumpet blasts. While large-scale resonance failure of massive mudbrick fortifications through human-generated sound alone is generally considered unlikely within modern structural engineering, such proposals have nevertheless highlighted an important conceptual point: collective synchronized human behavior may have played a role in the event described.

1.4 The Present Hypothesis

To the author's knowledge, relatively little attention has been given to the possibility that internal crowd loading dynamics may themselves have contributed to structural instability.

Ancient fortifications were primarily engineered to resist external attack forces such as battering, sapping, climbing, and projectile impact. They were not necessarily designed to resist sudden, concentrated, top-heavy lateral loading generated internally by large populations converging onto elevated perimeter structures.

This paper therefore explores whether the interaction between:

- crowd convergence,
- behavioral pattern disruption,
- mudbrick tensile weakness,
- hollowed casemate construction,
- and sloped revetment geometry

could plausibly have contributed to a reduction in structural stability under highly unusual circumstances.

Importantly, this paper does not attempt to resolve the broader chronological debate regarding the dating of Jericho’s destruction layers. Rather, it evaluates whether the proposed mechanism would be mechanically plausible under the specific fortification geometries, material constraints, and structural stratigraphy known from Bronze Age Tell es-Sultan (Kenyon & Holland, 1981).

2. The Unconventional Battlefield Design

One of the most unusual aspects of the Jericho narrative is the absence of conventional siege mechanics. The text does not describe siege ramps, battering rams, scaling assaults, or prolonged projectile warfare. Instead, the Israelite force repeatedly circled the city in silence over several days before abruptly changing the pattern on the seventh day (Joshua 6:1–20).

Several operational characteristics are notable:

- repetitive daily encirclement,
- prolonged silence,
- high predictability during the initial phase,
- and a sudden escalation through synchronized sound and movement.

From the perspective of modern behavioral analysis, repetitive non-combative exposure may under certain conditions alter defensive psychology. Initial vigilance can gradually transition into habituation as populations adapt to repeated stimuli that do not immediately culminate in attack (Thompson & Spencer, 1966; Rankin et al., 2009).

It is therefore plausible that the city population may have become increasingly accustomed to the daily encirclement pattern over time. Elevated wall positions, initially occupied primarily for military vigilance, may also have evolved into observation points from which civilians and defenders monitored the unusual activity below.

The seventh-day deviation from the established pattern — seven continuous circuits followed by synchronized horn blasts and shouting — may then have produced a sudden behavioral shift within an already crowded and tense urban environment.

This behavioral component remains speculative and cannot be directly reconstructed. However, it provides a possible framework through which unusual crowd concentration near the fortification perimeter could be explored.

3. Spatial and Demographic Context

Any analysis of internal loading dynamics requires at least a preliminary estimate of the spatial and demographic conditions within fortified Jericho.

Archaeological excavations indicate that the fortified core of Tell es-Sultan occupied approximately 5–6 acres (Kenyon, 1957). Although compact by modern standards, this represented a strategically significant fortified settlement within the Bronze Age Levant.

Urban density within ancient Near Eastern fortified settlements was frequently high. Domestic mudbrick structures were closely integrated, characterized by narrow circulation pathways and vertically layered living arrangements that maximized the limited spatial footprint within the defensive perimeter (Kenyon, 1957; Broshi & Gophna, 1984).

Under ordinary conditions, population estimates for fortified Jericho vary considerably based on urban density coefficients, though a baseline of several thousand residents within the 5–6 acre urban core is consistent with standard Levantine demographic models (Kenyon, 1957; Broshi & Gophna, 1984).

During periods of military danger, however, fortified oasis cities routinely functioned as regional refuges for surrounding agrarian populations (De Vaux, 1997). If such a refugee influx occurred during an imminent crisis event, temporary internal population density would have increased substantially beyond ordinary baseline occupancy limits.

The precise numbers remain uncertain and should not be treated as established fact. For modeling purposes only, this paper explores scenarios involving several thousand individuals within the fortified perimeter.

The significance of this demographic factor is not simply numerical. High-density populations can generate substantial dynamic loading effects when movement becomes synchronized, concentrated, or panic-driven.

4. Structural Characteristics of Tell es-Sultan’s Fortifications

The defensive system at Tell es-Sultan consisted of a composite architectural arrangement rather than a single homogeneous wall (Garstang, 1948; Kenyon & Holland, 1981).

Archaeological evidence indicates several major components:

4.1 Stone Revetment Foundation

The lower defensive system incorporated a substantial stone retaining wall built against the slope of the tell (Kenyon and Holland, 1981). This revetment stabilized the earthen mound while also creating a formidable external obstacle.

4.2 Mudbrick Superstructure

Above the stone foundation rose upper defensive walls constructed primarily from sun-dried mudbrick bonded with clay-based mortar (Garstang, 1948).

Mudbrick possesses several important structural characteristics:

- Compressive Performance: Relatively strong compressive performance under vertical dead loads.
- Tensile Strength: Very low tensile strength threshold (Houben & Guillaud, 1994).
- Stress Mechanics: Brittle cracking behavior when subjected to out-of-plane lateral stress.
- Shear Vulnerability: Vulnerability to shear separation when subjected to uneven or eccentric loading configurations (Varum et al., 2012).

4.3 Casemate Construction and Internal Voids

Evidence from Levantine fortification systems suggests that portions of Jericho's upper walls may have employed casemate-style construction, consisting of parallel wall sections separated by internal chambers (Kenyon, 1957). Such chambers could serve multiple functions including storage and habitation.

The biblical description of Rahab's dwelling integrated into the wall system (Joshua 2:15) is at least conceptually compatible with the existence of hollowed or inhabited wall structures.

From an engineering standpoint, internal voids, openings, and domestic modifications may reduce structural continuity and shear resistance relative to a fully solid wall mass (Houben & Guillaud, 1994). This does not imply structural weakness under ordinary conditions. However, it may increase sensitivity to unusual lateral loading configurations.

5. Behavioral and Mechanical Interaction Model

The present hypothesis proposes that the collapse mechanism, if historical, may have involved an interaction between human behavioral response and structural vulnerability.

The mechanism explored here is not based primarily on acoustic resonance. Rather, the focus is on crowd-induced loading redistribution.

5.1 Behavioral Concentration

If the seventh-day escalation generated widespread alarm, confusion, or curiosity within the confined urban environment, portions of the population may plausibly have moved toward elevated perimeter positions to observe the apparent onset of attack.

This movement need not have involved a literal simultaneous stampede. Even partial concentration of large numbers of individuals along limited elevated sectors could significantly alter local loading conditions.

5.2 Dynamic Loading Effects

Structural engineering distinguishes between three primary loading profiles (ASCE, 2016):

- Dead Loads: The permanent static weight of the structure's own masonry and components.
- Static Live Loads: The transient weight of stationary occupants under normal conditions.
- Dynamic Live Loads: the transient forces generated by moving, accelerating, or decelerating masses.

Moving crowds can produce significant transient force amplification beyond ordinary static occupancy loads (Bachmann & Ammann, 1987), particularly when:

- movement becomes synchronized or rhythmic,
- sudden deceleration occurs near edges or bottlenecks,
- or localized crowd density becomes unevenly distributed along specific structural sectors.

If large numbers of individuals gathered along elevated parapets and leaned outward to observe activity below, the resulting center-of-mass shift could theoretically introduce eccentric loading conditions.

In structures with low tensile capacity, such loading may contribute to cracking, sliding, or shear instability.

5.3 Structural Sensitivity

The proposed mechanism depends heavily upon several uncertain variables including:

- actual population density,
- crowd distribution,
- wall geometry,
- frictional interaction between wall components,
- material degradation,
- moisture conditions,

- and the presence of pre-existing structural weakness.

Consequently, the present model should not be interpreted as a deterministic reconstruction of events. Rather, it demonstrates that under certain assumptions, internally generated loading could potentially reduce stability margins within mudbrick fortification systems.

Nomenclature

- N = Modeled population involved in the internal loading scenario (dimensionless)
- m_{avg} = Average human body mass (kg)
- L_{sec} = Effective crowd concentration sector length (m)
- M = Total live human mass concentrated in the sector (kg)
- ρ_L = Equivalent linear mass distribution density along the wall (kg/m)
- g = Gravitational acceleration constant (9.81 m/s²)
- e = Lateral eccentricity distance of the shifted center of mass (m)
- W = Distributed downward weight force per linear meter (kN/m)
- M_{b} = Induced outward bending moment at the superstructure baseline (kN·m/m)
- F_{N} = Total normal downward force acting on the sloped interface (kN/m)
- F_{D} = Outward horizontal dynamic thrust vector generated by the crowd (kN/m)
- θ = Incline angle of the stone revetment foundation (20°)
- μ = Friction coefficient between the mudbrick superstructure and stone foundation (dimensionless)
- FS = Calculated Factor of Safety against sliding failure (dimensionless)

6. Exploratory Quantitative Modeling

The following calculations are presented as illustrative engineering approximations rather than definitive reconstructions.

The purpose of the model is not to prove that the collapse occurred exactly as proposed, but to examine whether internally generated forces could plausibly become large enough to influence wall stability.

6.1 Population Loading Scenario

For exploratory modeling purposes, let the baseline population and spatial constants be defined by the following parameters:

- Modeled Population (N): 3,000 individuals. This baseline represents a dense, localized refugee influx within the urban core during a military crisis event (Kenyon, 1957).
- Average Body Mass (m_{avg}): 60 kg. This value serves as a standard anthropologically adjusted average mass for a mixed-demographic ancient population consisting of adults and children (Houben & Guillaud, 1994).
- Effective Sector Length (L_{sec}): 325 m. This length corresponds to the approximate linear layout of a single high-exposure defensive sector along the excavated perimeter of the tell (Garstang, 1948; Kenyon & Holland, 1981).

Using these parameters, the total concentrated live human mass (M) within the active sector is calculated as:

$$M = N \times m_{\text{avg}} = 3{,}000 \times 60 \text{ kg} = 180{,}000 \text{ kg} \tag{1}$$

This concentrated mass yields an equivalent linear distribution density (ρ_L) along the superstructure baseline of:

$$\rho_L = M/L_{\text{sec}} = 180{,}000 \text{ kg} / 325 \text{ m} \approx 554 \text{ kg/m} \tag{2}$$

These values are hypothetical modeling assumptions only and remain highly sensitive to demographic and spatial uncertainties.

6.2 Eccentric Loading

If a concentrated crowd shifted outward along elevated parapets to observe activity below, a lateral eccentricity could theoretically develop within the upper wall system. For calculation purposes, let the mechanical constants and eccentricity variables be defined as follows:

- Eccentricity Estimate (e): 0.3 m. This represents a conservative geometric shift of the crowd's collective center of mass relative to the wall's central structural axis.
- Gravitational Acceleration (g): 9.81 $\mathrm{m/s^2}$.

Using the equivalent linear mass distribution density ($\rho_L \approx 554$ kg/m) from Equation 2, the approximate distributed downward weight force (W) per linear meter is calculated using standard geotechnical weight-force distributions (Das, 2019):

$$W = \rho_L \times g \approx 554\ \mathrm{kg/m} \times 9.81\ \mathrm{m/s^2} \approx 5.43\ \mathrm{kN/m} \tag{3}$$

The resulting simplified bending moment (M_b) induced at the base of the mudbrick superstructure is derived using classical structural mechanics for eccentric vertical loading over foundations (Bowles, 1996):

$$M_b = W \times e \approx 5.43\ \mathrm{kN/m} \times 0.3\ \mathrm{m} \approx 1.63\ \mathrm{kN{\cdot}m/m} \tag{4}$$

This value alone would not necessarily guarantee immediate catastrophic structural failure. However, when combined with several structural factors, it may contribute to a rapid reduction in overall structural stability margins (Houben & Guillaud, 1994; Bowles, 1996):

- Material Constraints: The low tensile strength threshold of unbaked earth matrices.
- Dynamic Amplification: Transient force spikes caused by synchronized or chaotic movement along elevated planes.
- Structural Discontinuities: Internal voids and reduced shear resistance resulting from casemate chambers or domestic modifications.
- Basal Boundary Conditions: The pre-existing stresses induced by a sloped stone foundation geometry.

6.3 Sliding Stability Considerations

The revetment geometry at Tell es-Sultan introduced an inclined interface between the lower stone retaining structures and the upper mudbrick components (Garstang, 1948; Kenyon & Holland, 1981).

Under simplified assumptions regarding wall mass, friction coefficients, slope angle, and dynamic crowd contribution, preliminary calculations suggest that the factor of safety against sliding could potentially approach marginal ranges under extreme loading conditions.

Utilizing a standard 3 × 3 structural layout matrix, the step-down evaluation of these driving and resisting forces along the $\theta = 20°$ inclined foundation interface resolves as follows (Das, 2019):

$$\text{Resisting Frictional Force} = \mu \times F_N \times \cos(20°) = 0.4 \times 193.78 \times 0.940 = 72.86 \text{ kN/m} \tag{5}$$

$$\text{Driving Force} = F_D + [F_N \times \sin(20°)] = 2.22 + 66.27 = 68.49 \text{ kN/m} \tag{6}$$

$$\text{Factor of Safety } (FS) = \text{Resisting Force / Driving Force} = 72.86 / 68.49 = 1.06 \tag{7}$$

Because multiple input parameters remain uncertain, this value should be interpreted only as an illustrative sensitivity outcome rather than a site-specific engineering determination.

Importantly, these estimates are highly assumption-sensitive. Small changes in the following variables can significantly alter the resulting stability margins:

- Interface Mechanics: The friction coefficient (μ) between the mudbrick superstructure and the underlying stone foundation.
- Structural Boundary Conditions: Localized wall geometry variations or shifting foundation slope angles.
- Environmental Degradation: Material moisture content fluctuations within the clay-mortar bonds.
- Crowd Dynamics: Peak crowd density localization and the level of physical force synchronization.

The calculations presented here should therefore be understood as conceptual plausibility demonstrations rather than validated finite-element structural simulations.

7. Discussion

The Jericho Structural Overload Hypothesis should be approached cautiously.

At present, the available evidence is insufficient to establish the proposed mechanism as historical fact. Significant uncertainties remain regarding:

- chronology,
- population density,
- exact wall geometry,
- construction details,
- and behavioral dynamics.

Nevertheless, the hypothesis may offer value in several respects.

First, it encourages interdisciplinary analysis between archaeology, engineering, and crowd dynamics.

Second, it reframes ancient fortifications not merely as static defensive barriers but as inhabited structural systems whose internal human activity may itself influence mechanical behavior.

Third, it highlights the possibility that nontraditional tactical behavior — particularly psychologically disruptive behavior — can interact with architectural vulnerabilities in unexpected ways.

Whether or not the historical event unfolded in this manner, the broader conceptual relationship between crowd behavior and ancient structural stability may warrant additional study.

Future investigation could include:

- finite-element structural modeling,
- experimental mudbrick simulations,
- comparative analysis with other ancient fortifications,
- and formal crowd-dynamics reconstruction.

8. Conclusion

This paper has explored the possibility that internally generated crowd loading may have contributed to instability within the fortification system of ancient Jericho under highly unusual conditions.

The central claim is intentionally modest: not that the biblical narrative has been conclusively explained through engineering analysis, but that the interaction between crowd behavior, mudbrick structural limitations, and concentrated lateral loading may represent a mechanically plausible avenue for further interdisciplinary exploration.

The hypothesis remains speculative and requires rigorous evaluation by specialists across multiple fields.

If nothing else, the model highlights an important conceptual insight: ancient fortifications were primarily engineered to resist external assault, not necessarily sudden internal loading concentrations generated by the movement of the defended population itself.

Statement on the Use of AI Assistants

Declaration of Generative AI and AI-assisted technologies in the writing process: During the preparation of this manuscript, the author utilized the generative AI platforms Gemini (Google) and ChatGPT to facilitate literature research assistance, technical drafting, typesetting validation, mathematical formatting, and structural copyediting. Specifically, these technologies were leveraged to cross-verify reference metadata, format quantitative engineering approximations in alignment with standard publication nomenclature and to optimize the 3×3 layout matrix calculations.

Following the use of these services, the author reviewed, verified, and edited all content to ensure technical accuracy and analytical consistency. The author maintains sole responsibility for the core conceptual hypothesis, the determination of baseline modeling assumptions, and the final interpretations presented in this paper.

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