A Novel Method for Constructing the Pyramid of Khufu:

The Tilt Levering Cage Hypothesis

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APPROXIMATELY 4,500 years ago, the Egyptians constructed the three pyramids at Giza. It is estimated that more than 20,000 workers participated in the construction of Khufu's pyramid (Lehner, 2017). This 'Great Pyramid', attributed to Pharaoh Khufu, is the focus of this paper. It was built using 2.3 million building blocks over a period of approximately 20 years.[1]

At the time, the Egyptians lacked knowledge of wheels for transportation and pulleys for lifting with ropes. Their tools consisted of hammers, saws, chisels, and drills made of wood, natural stones, and copper. Egyptian craftsmen excelled in creating robust wooden joints, using techniques such as mortise and tenon joints secured with dowels or clamps. They employed ropes crafted from palm fibre and papyrus reed, enabling them to pull and drag objects. Given their practice of caulking seagoing vessels, it is evident that they were familiar with naval techniques, such as keeling a ship and supporting it with box cribs.

For centuries, the construction of the Giza pyramids has remained a mystery. The generally accepted method involves the use of ramps made from stone and sand.[2] However, desert sand has low internal friction, making it likely that such ramps would collapse under their own weight. Khufu's pyramid consists of more than 200 layers of stone. A ramp would have been necessary for the second layer, and subsequently expanded and raised approximately 200 times. This would have caused significant and time-consuming interruptions, occurring every few weeks on average, even if such ramps were structurally feasible in the first place.

The pyramid-building method proposed here offers a straightforward solution to many of the remaining uncertainties surrounding pyramid construction, demonstrating a practical application of naval engineering. An article on this topic was published in *ENiM* 15, 2022, p. 245-264, authored by Mullers, Borgart, Kaper, Bast, and Kuipers, which includes an analytical description of the mechanical behaviour of the Tilt Levering Cage (TLC).[3] Additionally, this research was featured in the *Journal of National Geographic Historia* 2, 2023.

In the following text, we will explain how a transporting and lifting device could have been constructed using nautical techniques. We will describe how such a device might have been

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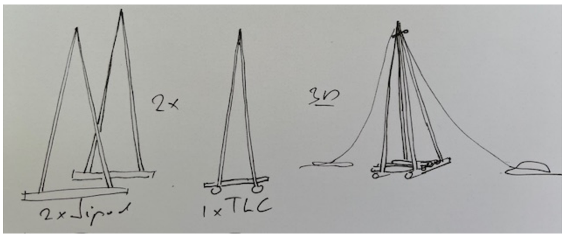
[1] M. LEHNER, Z. HAWASS, *Giza and the Pyramids*, London, 2017, p. 419.
[2] *Ibid.*, p. 415.
[3] B. MULLERS, A. BORGART, O.E. KAPER, B. BAST, E. KUIPERS, « Building pyramids. Reconstructing the process of lifting stones », *ENiM* 15, 2022, p. 245-264.

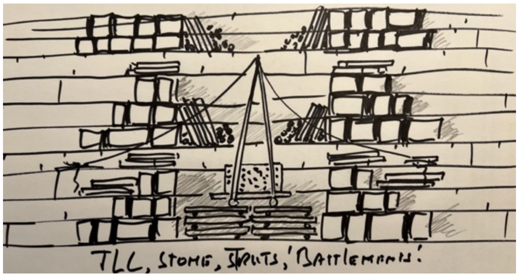
used to raise the building blocks up the pyramid, as well as how it could have lifted the massive blocks for the interior chambers. We will demonstrate how this lifting method determined the slanted slope of the pyramids. Finally, we will present plausible evidence for this technique, sourced from ancient texts, hieroglyphs, and the stone layering of Khufu's pyramid, along with potential discoveries that could be made with minimal excavation.

The Tilt Levering Cage

Tilt Levering Cages (TLCs) could have been employed to transport building blocks horizontally and, using box cribs, elevate them up the pyramid. To construct a transporting device like a TLC, the Egyptians may have utilised a lever structure composed of two bipod ship mast frames, commonly used at the time.[4] Two such mast frames could have been firmly connected at their apex with a crossbar, with posts fixed over the two girders at the base to form the loading floor. This created a high lever structure that could be tilted by manpower, rocking back and forth over one girder or the other with ropes attached to the top [Fig. 1].



A Tilt Levering Cage (TLC) constructed from two bipod mast frames. The two frames are connected at the top by a crossbar, with cedar mast poles forming the base. The loading floor consists of posts fixed to both girders at the bottom.



A drawing of a transport stair. Stones parked on either side of the platform resemble battlements. Positioned on the platform is a loaded TLC atop two side-by-side box cribs.

Fig. 1

Strong and durable cedar wood was the preferred material for constructing bipod mast frames, and thus for TLCs. Straight, slender cedar trees without significant branches could grow to heights of at least 40 metres and were abundantly available in the Levant's dense forests. Although expensive, cedar wood was accessible to the affluent Egyptians. As early as 100 years before the construction of the pyramids at Giza, King Snefru had organised a fleet of 40 ships to travel to the Levant and negotiate with the Phoenicians for cedar wood. The long tree trunks were transported as rafts, towed from Byblos to Egypt and up the Nile River.

Most of the limestone for constructing Khufu's pyramid was quarried locally. However, granite blocks and whitish casing stones, sourced from Aswan and Tura respectively, were transported to Giza by boat along the Nile.

The largest building blocks of Khufu's pyramid, located in the first layer, were hauled into place using sledges. Hauling these heavily loaded sledges across desert sand was likely

[4] E. ANGELUCCI, A. CUCARI, *Ships*, New York, 1975, p. 18.

impossible due to the risk of becoming stuck. Instead, it is plausible that the sledges, for all horizontal transport, were moved on roller posts laid over tracks constructed from long cedar trunks laid like rails. The naturally slightly tapered roller posts were arranged crosswise and alternately on the rails in front of the sledges ensuring the sledges remained on track. Where possible the cedar trunks used as rails may have been partially buried for stability, leaving only a small visible portion for use of the roller posts.

The second-largest blocks, situated in the second stone layer, were the first to be lifted. The Egyptians may have employed naval engineering to construct a manually operated TLC, with ropes affixed to the top and positioned on two stackable side-by-side supports. These supports were composed of stacked, perpendicular posts arranged in layers a technique known as box cribbing.

If devices like TLCs and box cribs were employed, the Egyptians must have understood their mechanical principles and implications just as thoroughly as we do today. To aid comprehension, this paper includes an appendix providing estimates of various dimensions, including the maximum width of building blocks, the distance between the bearing points of crib posts, the safe support height of box cribs, the length of the girders of a TLC, the spacing between these girders, and additional related measurements.

With ropes attached to the top, the Egyptians could tilt a loaded TLC (Appendix 5) over a girder at its base, thereby lifting the opposite girder. This elevated girder would be supported by a box crib, which was incrementally raised as the girder was lifted. By tilting the TLC back and forth, a loaded TLC would gradually rise, within the height limits imposed by the box cribs, atop two 'growing' box cribs.

Using TLCs and box cribs, the Egyptians may have discovered that the largest blocks lifted, such as those in the second layer of Khufu's pyramid, should not exceed approximately 2.5 tons (Lehner and Hawass, 2017). To maintain the manageability of the TLC and the crib posts (Appendices 1 and 2), the width of the building blocks likely did not surpass 0.8 metres (Appendix 6).

For reference, the cubit – a unit of length approximately 0.52 metres – was equivalent to seven palms, with each palm equalling four fingers.

The Egyptians may have utilised square box cribs (Appendix 1), approximately 1.5 metres wide or more likely three cubits at the time (appendix 7), with girders of similar length for TLCs. They may have determined that lifting 2.5-ton blocks a few metres upwards was feasible using standard TLCs (Appendix 1), manually tilting this loaded device atop two side-by-side box cribs.

As a general guideline for box cribbing, the safe support height for square box cribs is three times the distance between the bearing points (Appendix 9). For a 1.5-metre box crib, this results in a maximum height of 3.6 metres (3 × 1.2 metres). In practice, a limit of approximately 3 metres, or more likely 6 cubits, could have been chosen for safety and convenience for workers (Appendix 9).

The weight supported by square box cribs, composed of perpendicular layers of two parallel cedar posts, would not have been a concern, as such cribs can bear loads far exceeding 2.5 tons. Similarly, the axial forces on the TLC poles would also have been manageable (Appendix 10).

The pulling force required to tilt a Tilt Levering Cage (TLC) would be well within the capabilities of an average worker. The distance between the girders is estimated to be approximately 0.6 metres (Appendices 3 and 4). The largest building block to be lifted weighs about 2.5 tons, and the top of the TLC could have reached a height of approximately 5 metres.

According to the lever principle, the horizontal pulling force necessary to tilt a fully loaded TLC would amount to 150 kilograms. If 15 workers were engaged in the task, each individual would need to exert an initial force of only 10 kilograms for the heaviest blocks. Pulling at an angle of 45 degrees would increase the initial force by a factor of 1.4 ($\sqrt{2}$), as calculated using Pythagoras' theorem. It should be noted, however, that as the TLC tilts, the centre of gravity of the load shifts towards the vertical pivot line, eventually reducing the pulling force required to zero.

Lifting the Stones up the Pyramid

The steps of the Pyramid of Khufu served as stairs for workers, but they were not deep enough to accommodate 3-cubit square box cribs. To facilitate transportation, temporary transport stairs may have been created, resembling the pyramid's steps but on a larger scale. These stairs may have been left open within the flanks by temporarily relocating stones to create the platform. These stones were placed on multiple pyramid steps on either side of the newly built platform. These platforms were spaced between a minimum of 4 cubits and a maximum of around 6 cubits apart in height (appendices 8, 9, and11). These transport stairs likely ran parallel to each other, spaced about 15 metres apart on all sides of the pyramid, providing an efficient means of moving the building blocks upwards [Fig. 1, right].

The 230-metre-square base of the Pyramid of Khufu may initially have accommodated a total of 60, or perhaps as many as 80, temporary stairways. This number would have gradually reduced to 4 central stairways leading to the summit.

The platforms of these transport stairs – beginning with the first platform atop the second stone layer – needed to be at least 3 cubits and 1 palm deep to ensure that the square 3-cubit box cribs did not extend beyond the edge (Appendix 8). The height between successive platforms should not have exceeded the safe and comfortable limit of about 6 cubits (Appendices 9 and 11).

To construct a platform for a transport stair, stones could have been manoeuvred across the pyramid steps using roller posts, positioning them on more pyramid steps on both sides of the platform. From a distance this may have given the appearance of battlements [Fig. 1, right].

On a platform, a loaded Tilt Levering Cage (TLC) may have been lifted atop of two box cribs. Once at the appropriate height, the TLC was carefully lowered onto a stone layer using roller posts. From there, it could either be moved to its designated unloading location or prepared for the next lift using box cribs (link here).

Aside from the initial and final stages, an average of 1,000 platforms could have been operational, based on 60 temporary stairways distributed across all sides of the pyramid. Without obstructing one another, the pulling teams may have operated their TLCs in a way that limited the utilisation rate of platforms to approximately 30-40%. Accounting for repair work and transportation from nearby quarries, the total number of TLCs in operation may have reached 500-600.

Near the pyramid's corners or its apex, tilting a TLC may have been difficult due to limited space for the rope teams. In such cases, additional, slimmer bipods could have been placed at an angle against the base of the TLC on one or both sides, enabling tilting by pulling down on these auxiliary supports.

The final task for which the transport stairs might have been used was to move the backing stones and whitish casing stones upwards to construct the pyramid's final cover layer. This layer may have been built from the top down. The uppermost platforms of the transport stairs could have been gradually dismantled by moving the parked stones back into the platform, just before being covered by the top layer.

The construction of the cover layer may have been a continuous, top-down process of stacking stones against the pyramid, supported by multiple steps. This process could have commenced at the summit, proceeding from the corners toward the central stairs of each face, and ultimately reaching the base. It is conceivable that this top-down construction was executed simultaneously on all sides of the pyramid. The structure of stacked cover stones across multiple steps, supporting this process, is still visible in the remnants at the base of the cover layer on top of the Pyramid of Khafre.

A loaded Tilt Levering Cage (TLC) atop box cribs might have been lifted from one platform to the next in approximately 7-9 full swings, with each swing estimated to raise the TLC by about 0.3 metres. This process would take an estimated 30 minutes per lift. At the beginning of construction, 60 transport stairs (15 on each of the four sides) may have been in use, enabling the upward movement of up to 120 blocks per hour, or 1,440 blocks in a 12-hour workday. This rate would equate to more than 500,000 blocks per year. As construction progressed and only four central stairs remained near the top, 96 blocks could have been transported upwards per day.

In the early stages of construction, manpower was likely concentrated on quarrying stones. However, as building blocks required transportation to greater heights, transport became more time-consuming, necessitating the allocation of labour to these tasks.

For reasons of efficiency, TLCs would have been fully loaded. At higher levels of the pyramid, where building blocks were significantly smaller (Petrie, 1883), it may have been possible to transport more than one block in a single TLC at a time. Factoring in seasonal delays and other setbacks, a construction timeline of 20 years for the 2.3 million blocks of Khufu's pyramid seems plausible.

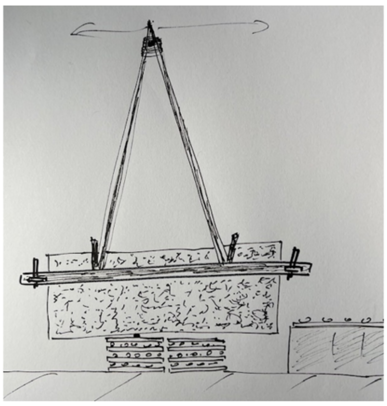


Fig. 2. The heaviest building blocks, weighing 50 tons or more, for the interior chambers may have been tilt-lifted onto sturdy, solid box cribs. The blocks were lifted and transported back and forth, almost in place, each time onto the next layer of stone.

The massive stones for the interior chambers, some weighing 50 tons or more, may have been tilt-lifted simultaneously with the construction process, layer by layer. These stones could have been positioned on the building ground near their intended location but tens of metres higher. They may have been tilt lifted onto two solid box cribs, before they were moved onto the next layer of stone. This process could have been repeated layer by layer to the intended height, as the structure rose [Fig. 2].

The pulling force required to tilt these heaviest stones would have been well within the capabilities of a team of 125 workers. The distance between the pivot points may have been approximately 0.6 metres. The largest building blocks to be lifted weighed around 50 tons, and the top of the constructed lever could have been approximately 12 metres above the pivot point.

According to the lever principle, the horizontal pulling force required to tilt a massive stone would amount to 1,250 kilograms. If 125 workers were involved in this task, each individual would need to exert an initial force of just 10 kilograms.

A Uniform Estimate of Pyramid Slopes

In ancient Egypt, the slope of a structure was measured as a *seked*. A *seked* represents the ratio of the number of palms and fingers in the horizontal plane to the height of one cubit. The *seked* of Khufu's pyramid is 5 palms and 2 fingers (where one palm equals 4 fingers) horizontally for every cubit vertically.[5]

Near the apex of Khufu's pyramid, it appears that a practical decision was made by the architects to construct many successive, almost evenly sized stone layers, each measuring approximately 0.52 metres in height, or slightly more.[6] These layers likely correspond to the Egyptian unit of one cubit or a little more in thickness.

Platforms for transport stairs at this altitude, constructed using three layers of stone, each one cubit high, would have provided a safe and comfortable lift height of 4 cubits. The depth of such a platform, based on the seked, would measure 3 cubits + 1 palm (4 × 5.5 palms). We estimated the dimensions of a square box crib to be 3 cubits A platform depth of 3 cubits + 1 palm could accommodate a 3-cubit box crib, preventing it from extending beyond the edge (Appendix 8).

Given these measurements, it is possible that the architect's decision from the outset was determined by the limitations of lifting with box cribs. They may have decided that, when working with 3-cubit box cribs on 3-cubit + 1-palm platforms, the safe lift height – and consequently, the slope – should be 4 cubits.

At lower altitudes, platforms may have been slightly deeper, allowing for proportionally greater lift heights. However, the lift height should not exceed the safe limit of approximately 6 cubits, thereby restricting the platform depth (Appendix 11).

The constraints of working with box cribs could explain the relatively consistent maximum slope of approximately 54 degrees observed not only in the Giza pyramids but in many others as well. If ramps had been used instead, the Egyptians would not have been limited by maximum slope angles and could have constructed pyramids with a greater variety of shapes and steeper inclinations, as seen in pyramid hieroglyphs [Fig. 4].

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5 M. LEHNER, Z. HAWASS, *op. cit.*, p. 172.

6 W.M.Fl. PETRIE, *op. cit.*, Plate VIII (Courses of the Great Pyramid Mansory).

The architect of Khufu may have decided to move the building blocks upwards simultaneously on all sides. If this had been the architect's plan from the outset, then consequently, in combination with the proposed construction technique, it would have determined not only the slope angle but also the overall shape, of the pyramid. Additionally, the width of the square base would have set its final height.

Rectangular, lightweight wooden triangles measuring 3 cubits and 1 palm in base length and 4 cubits in height – or smaller triangles maintaining the same ratio – could have served as practical tools. These triangles, along with taut cords and plumb lines, would ensure the accurate slope of transport stairs and serve as a reference for the correct slope of the pyramid's faces.

A critical factor in constructing a straight and symmetrical pyramid was maintaining a clear reference point marking the exact centre of the structure throughout the construction process. Both reference points – the exact centre and the slope – would have been instrumental in ensuring precise control at each successive layer of stone.

The combined concepts of Tilt Levering Cages (TLCs), box cribs, and transport stairs may provide a comprehensive explanation for the longstanding mysteries surrounding pyramid construction. While the use of TLCs appears plausible, it must be noted that there is currently no concrete evidence to support this hypothesis.

Textual Indications

Although the Egyptians documented many aspects of daily life, no known references explicitly describe the construction methods of the pyramids. Given the extensive duration and the vast number of people involved in building these monumental structures, it is unlikely that the construction method could have been deliberately concealed. However, potential clues regarding the techniques used may be found in the writings of Herodotus, as well as in hieroglyphs and the patterns of stone layering.

In *Histories*, the work of the Greek historian Herodotus, who visited Egypt around 500 BCE, his description of pyramid construction aligns with the concept of a Tilt Levering Cage (TLC) on box cribs operating along transport stairs.[7] He wrote of "a flight of stairs" and "platforms, or some call them battlements," on the pyramid [Fig. 1, right]. Additionally, Herodotus mentioned a "device made of short pieces of wood." Could his informants have been referring to box cribs passed down through oral tradition? Was the TLC, which "hoisted the stones from one tier to another," part of this description [Fig. 3]?

Furthermore, Herodotus stated that the construction of the pyramid's cover layer was performed top-down, a method entirely consistent with the approach proposed here. Despite these apparent parallels, Egyptologists have generally dismissed Herodotus's accounts of pyramid construction as unreliable, citing hearsay and inaccuracies.[8]

[7] R.B. Strassler (ed.), *The Landmark Herodotus: The Histories*, New York, 2007, p. 174.

[8] *Ibid.*, p. 174.

Fig. 3. The author lifted 300 kg using box cribs with a pulling force of about 20 kg and moved this weight horizontally using roller posts with ease. On the right, one additional bipod has been added for tilting by pulling down, click here.

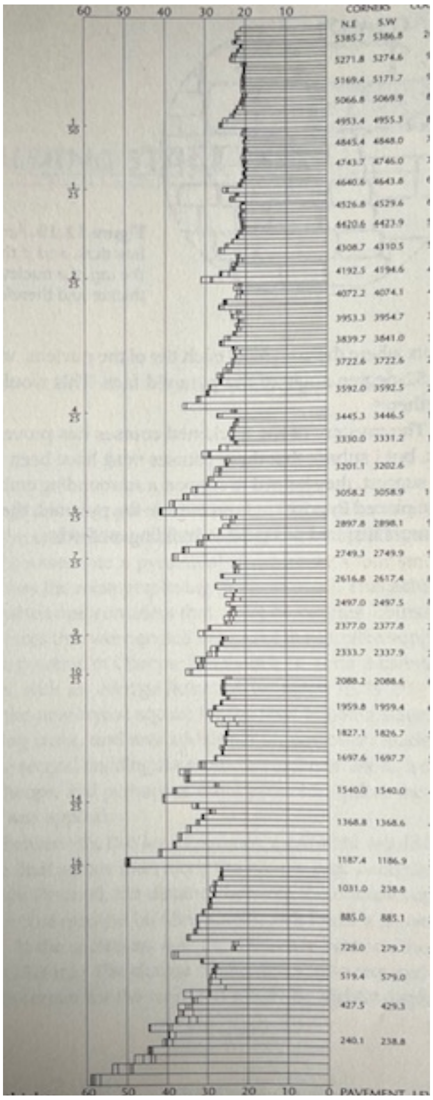
Petrie's Chart

Petrie's Chart illustrates the heights of the successive stone layers of the Pyramid of Khufu.[9] The heights of the stone layers are displayed on the y-axis, while the x-axis features flat boxes indicating these same heights, but enlarged [Fig. 7, left].

On the right, Petrie's Chart is supplemented by the author with consecutive shaded blocks representing height differences between possible platforms of transport stairs. These shaded blocks consist of 2, 3, or 4 successive stone layers. The added heights of these stone layers are represented on the y-axis and enlarged, marked as dots, on the x-axis [Fig. 7, right].

These possible platforms of transport stairs could have been positioned continuously from the base to the summit of Khufu's pyramid. The height differences between these possible platforms are illustrated in a block graph derived from Goyon's figures.[10] The average height difference is 2.6 metres, with a minimum of 2.08 metres and a maximum of 3.265 metres [Fig. 8]. This range ensured sufficiently deep platforms at every level while remaining within the limits of lift heights. Expressed in cubits, the lift height was likely at least 4 cubits and was limited around 6 cubits (Appendix 12).

[9] W.M.Fl. PETRIE, *op. cit.*, Plate VIII (Courses of the Great Pyramid Mansory).
[10] G. GOYON, "Les rangs d'assises de la Grande Pyramide," *BIFAO* 78, 1978, p. 410-413.



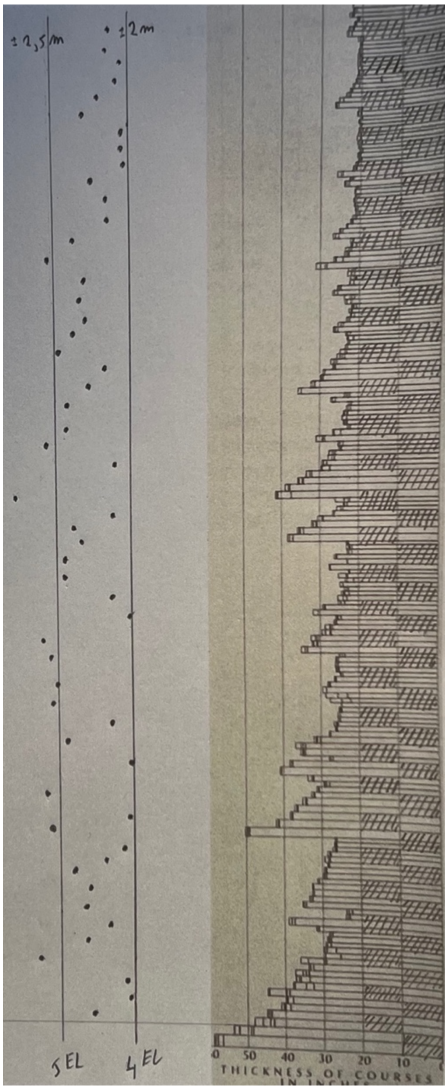


Fig. 7. On the left: the original Petrie's Chart of Khufu's pyramid (1883), indicating the heights of successive stone layers. On the right: the modified chart by the author, featuring successive shaded blocks and dots on the x-axis to represent the height differences between possible positions of platforms for transport stairs.

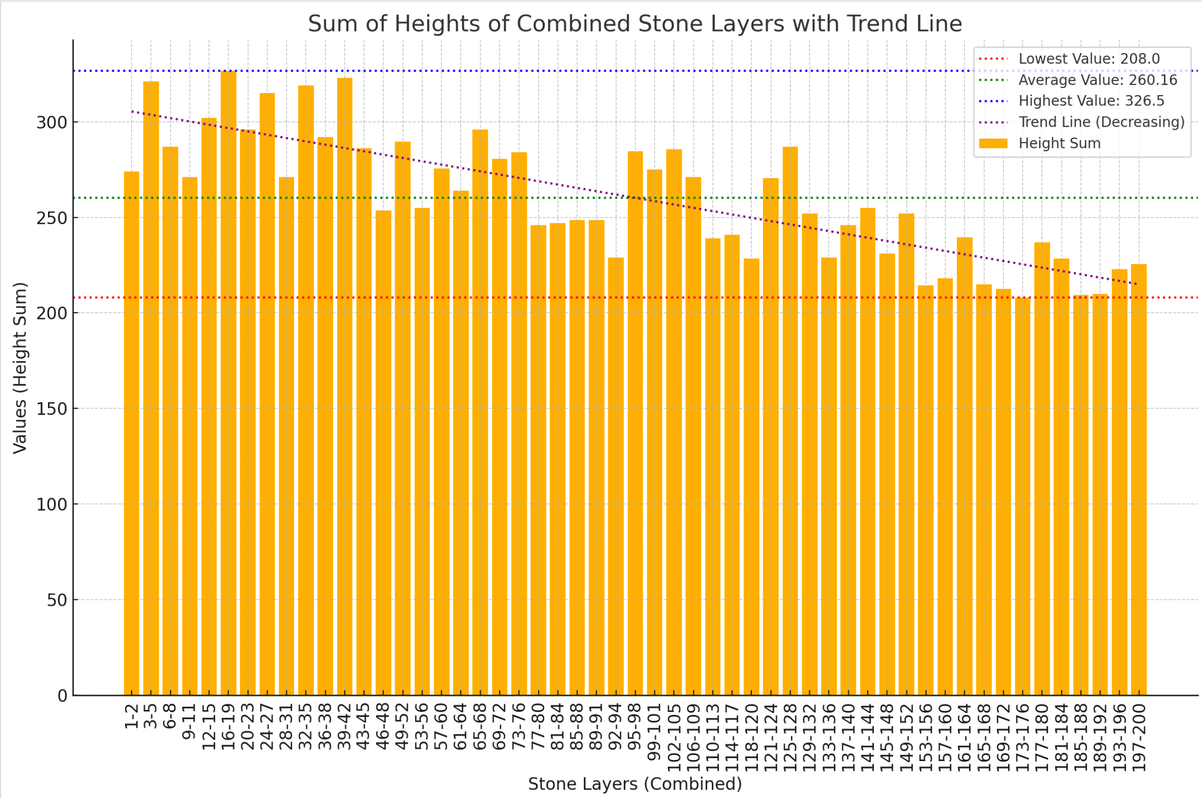


Fig. 8. Graph of Calculated Possible Steps Using Goyon's Figures**.** The proposed minimum step height of 4 cubits (2.08 metres) aligns with the figures provided by G. Goyon. This calculated graph may suggest that the possible step height was not coincidental but a deliberate design choice during construction.

These possible positions of transport stair platforms could help resolve the puzzling question of the varying heights of the stone layers in Khufu's pyramid.

Discussion

The evidence for the use of Tilt Levering Cages (TLCs) and platforms is indirect. However, the Egyptians must have been capable of adapting shipbuilding techniques for pyramid construction. It is clear that the Egyptians of the time possessed the knowledge and tools necessary to construct a TLC. Additionally, lifting stones to a height of 146 metres using a ramp is technically implausible.

Although the likelihood of finding physical remnants of TLCs is slim, investigating the steps of Khufu's pyramid could yield valuable insights. First, measuring the width of the stones could determine whether they would fit into a standard TLC. Second, evidence could be sought in the form of vertical masonry joints at least 3 metres (or 6 cubits) long on the pyramid's steps.

During the top-down construction of the cover layer, the uppermost platforms were successively closed. Parked stones were moved back into place, restoring the original pyramid steps. Behind the upper restored step of a former platform, there might be a vertical masonry joint between this restored step and the rise of the preceding platform [Fig. 9]. This joint should measure at least 3 metres in width, corresponding to the size of two side-by-side 21-palm box cribs. These vertical joints could be located on the pyramid steps, aligned at intervals of approximately 2.5 metres, or more likely 5 cubits, in height. Such joints could be revealed by sweeping the pyramid's steps with a broom. The presence of these joints would provide strong evidence in support of the proposed theory.

At present, the use of a Tilt Levering Cage on box cribs, combined with transport stairs, appears to be the most plausible method by which a civilization from 4,500 years ago could have constructed Khufu's pyramid without external intervention, such as assistance from extraterrestrial beings.

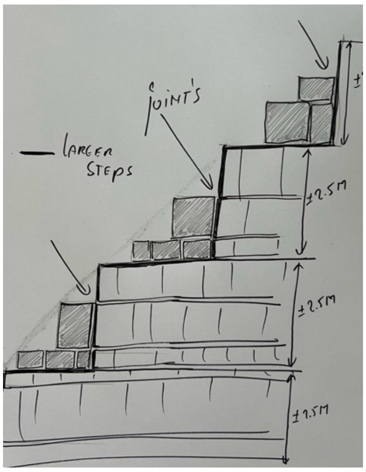


Fig. 9. Masonry joints might possibly indicate former platforms.

Conclusion

The proposed pyramid-building hypothesis, inspired by shipbuilding techniques, offers a viable solution to all aspects of Khufu's pyramid construction and potentially to pyramid construction in general. It highlights the practical application of nautical architecture and engineering during that era.

Overall, the concept of Tilt Levering Cages (TLCs) as a plausible construction method warrants further investigation and study. This approach could provide valuable insights into the remarkable construction achievements of ancient civilizations worldwide.

Appendix

Requirements of Box Cribs, TLCs, and Stone Layers of Khufu

1. Uniformity for Efficiency: Tilt Levering Cages (TLCs) and box cribs may have been standardised for efficiency. Uniform crib posts could result in square box cribs, with girders of a TLC potentially matching the length of crib posts. Platforms were likely sized to accommodate at least two side-by-side box cribs.

2. Lightweight Construction: Lightweight wooden constructions were likely preferred, as this would facilitate the manual transport of empty TLCs and crib posts.

3. Box Crib and Its Bearing Points: The bearing points of a box crib were probably aligned vertically and positioned approximately 0.15 metres from the ends of the crib posts to prevent slipping and splitting. Consequently, the closest bearing points of two side-by-side box cribs were likely spaced about 0.3 metres apart, or more likely 4 palms in ancient units.

4. Spacing of TLC Girders: The two girders of a TLC resting on side-by-side box cribs may have been positioned close to the bearing points of the box cribs to minimise bending stress on the top crib posts. We estimate that the girders were placed about 0.15 metres inside their bearing points, resulting in a spacing of approximately 0.6 metres (0.15 m + 0.3 m + 0.15 m), equivalent to 1 cubit plus a palm.

5. Building Block Placement on TLCs: Building blocks on a TLC's loading floor were likely placed lengthwise across both girders to prevent toppling during tilting.

6. Stone Sizes and TLCs: The largest building blocks to be lifted, located in the second stone layer, may have been cut to fit into a standard TLC. These blocks, weighing up to 2.5 tons, were approximately 1.27 metres high and the same but slightly varying length. Based on a density of 2.5 tons per cubic metres the maximum width may be about 0.8 metres. This should be verified on Khufu's pyramid.

7. Bearing Points Beneath TLC Girders: The support points for box cribs under the TLC girders were positioned as a compromise: close to the load to minimise bending stress and spaced apart for stability. With a load width of 0.8 metres, the support points were likely positioned 0.2 metres from each side, totalling 1.2 metres. Including an additional 0.15 metres at each end to prevent slipping and splitting, the crib posts and girders likely measured 1.5 metres in length, or more likely 3 cubits at the time.

8. Depth of a Platform for 3-Cubit Box Cribs: Platforms for 3-cubit square box cribs required a depth of 3 cubits plus an additional palm (22 palms) to prevent the cribs from extending beyond the edge.

9. Safe Box Crib Height: The safe height for a square box crib is limited to three times the distance between its bearing points, estimated at 1.2 metres. While the theoretical maximum height is 3.6 metres, a practical limit for safety and worker comfort was likely around 3 metres (6 cubits).

10. Safe Load on Box Cribs and TLC Poles: Properly constructed box cribs could support loads far exceeding the weight of the largest pyramid blocks (2.5 tons). Calculations using Euler's formulas confirm that the tensile and compressive forces on TLC poles were also within safe limits.

11. Lift Height Between Platforms: The safe and practical lift height when working with two side-by-side 1.5-metre box cribs was likely limited to roughly 3 metres (6 cubits). The height between possible platforms of transport stairs should correspond accordingly.

12. Stone Layers of Khufu: To accommodate 3-cubit box cribs, uninterrupted height distances between stone layers for potential platforms were necessary, with a minimum height difference of 4 cubits and maximum of roughly 6 cubits. This range ensured sufficient deep, safe and comfortable lift heights.

The First Experiment with a Full-Size TLC

The first successful experiment with a full-size Tilt Levering Cage (TLC) involved tilt-lifting a weight of 2,370 kilograms, achieved with a pulling team of 12 people [Fig. 10].

Fig. 10. The first TLC lift experiment.