

Efficient Construction of the Great Pyramid

(Abstract only)

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1.1 Abstract

The Great Pyramid of Giza was built around 4,600 years ago. It has a height of 146.6 m and consists of about 6.5 million tons of stones. ^[3]

Archaeological evidence alone has not been sufficient to determine the construction method of the pyramid. ^[4]

On the other hand, the project was ambitious and had to be completed within 20 years during the Pharaoh's lifetime. Assuming a construction period of 20 years and an average workforce of approximately 12,200 workers under human working conditions, substantial deviations from an efficient construction method would have resulted in a significantly longer construction period.

Efficiency therefore provides an additional constraint and a second source of information. The basic guiding principle was: **simple methods applied intelligently**.

Through mathematical modeling and analysis, this problem can be systematically constrained using only the elementary arithmetic and geometric operations that were available at that time. ^[5] ^[6]

This allows a chain of decisions to be established, leading to a specific solution for each element:

- The efficiency constraints require a ramp system that rests on the existing truncated pyramid, thereby minimizing ramp material while maintaining sufficient transport capacity.
- During construction, part of the ramp material is recycled from the bottom upward, reducing the required ramp material to approximately 6 % of the pyramid's volume.
- Comparative calculations show that using sliding sledges with Nile mud instead of sledges on wooden rollers would have extended the construction time by approximately 6 years. The decisive factor is not the higher friction of sliding sledges, but the large number of water carriers required and the resulting wider ramps.

The proposed model shows that the Great Pyramid could have been constructed within 20 years under humane working conditions, provided that a highly efficient construction method was used.

1. <https://scholarship.claremont.edu/jhm>

2. https://en.wikipedia.org/wiki/Claremont_Colleges

3. https://en.wikipedia.org/wiki/Great_Pyramid_of_Giza

4. https://en.wikipedia.org/wiki/Construction_of_the_Egyptian_pyramids

5. https://en.wikipedia.org/wiki/Ancient_Egyptian_mathematics

6. Frank Müller-Römer, Der Bau der Pyramiden im Alten Ägypten, Renidere Verlag, 2024, (pp. 163 - 167)