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Theory of Construction of the Giza Plateau Pyramids

(Original title: Hypothesis of construction of the pyramids of the valley* of Gizeh (Giza))

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It is gratefully to have known many persons interested in this work over all Internet, many of them helped me without any kind of interest, bringing me very valuable resources and information.

Abstract:- The following theory pretends to expose the probable technique used by ancient Egyptians to lift and rise at the height of 145 meters all blocks and constructive elements that compound the pyramids of the Giza plateau, specially the Khufu pyramid.

Two types of ramps are exposed in the work. The model elaboration was made taking approximate dimensions that have blocks that compound the pyramids – more precisely, Khufu pyramid -, utilizing geometric basic forms, physics-mathematical simple reasoning and measures of common lengths to the epoch. A suitable angle for the slope must be determined to make possible annulling almost completely the action of gravity force, to obtain a ramp that satisfies two fundamental conditions:

I- Transform the moving blocks work to overcome only the friction force when dragging them and not into overcome the action of gravity force on them.

II- Facilitate move the blocks in a comfortable, safe and fast way, making possible to accomplish complex maneuvers with a minimum risk; even when its implies traveling bigger distances and to transfer a bigger number of elements that compose ramps and their talus.

The First type of ramps constitute the main part of this work due it provides the effective technique to solve the incognita of how were raised all constructive components to reach the desired height of 146 meters that had the Khufu pyramid in their splendor times. The second type of ramps provides the technique to improve to the maximum the existent relation between the pyramid constructive process and the possibilities to finish this process in real time according with the constructive techniques that existed on that time.

The core of the talus system is composed by calcareous rock, which provides a great stability to the system and the talus system consists of clay mortar from Giza plateau named "TAFLA", limestone slabs and vegetable fiber, which give to this system a very high stability.

Keywords:- *Theory; Pyramids; Construction; Khufu; Cheops; Giza; Plateau.*

I. PRESENTATION

This work, "Giza plateau pyramids construction theory, originally called "Hypothesis of construction of the pyramids of the valley of Gizeh (Giza)", conceived in 2002 year by me, Carlos Eduardo Rodríguez Varona, with the help of the coauthor, my late father, Dámaso René Rodríguez Vives, copyrighted under the 90-2003 copyright on CENDA, La Habana, Cuba, in 2003 year; have as main goal to develop and expose a technique that facilitates as most correct as possible an explanation to the mystery of Giza plateau´s pyramids construction, in Egypt, and in some way facilitate to establish and/or shape the following statements:

- First: demonstrates that ancient Egyptians were the true builders of such grandiose pyramids. It have been a lot speculated - and still it is continued doing so -, about the possibility that some supernatural or extraterrestrial creatures were the true creators and not the ancient Egyptians, as really was, it verified thanks to excavations that showed the builders city that built these colossal pyramids. Many people have been serving of the lack of a correct construction explanation of these pyramids to obtain profit to their own benefit; standing blindly in front these amount of evidences founded in this excavated Giza plateau pyramids builders city.

- Second: to set in a definitive way that ancient Egyptians were the real artificers of these enormous constructions and these constructions greatness shall be definitively showed to the worldwide public correctly, because at the end it does not have the correct significance if it is not exhibited correctly explained, but only mere unexplained constructions, especially for new generations which always will ask how were made these magnificent constructions with so rudimentary resources with regard current times. This would contribute to the scientific and rational thought

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of the humanity, demonstrating that – as always have been happening - big works have always been made by persons with correct thoughts and not by mysterious or hidden beings.

- Third: to make possible remove in a definitively way the emptiness these pyramids construction´s not explanation represents to the history. This have special importance, both for the Egyptians to the rest of humanity, which always had seen - and will see forever - the ancient Egyptian people as one of the main centers of human civilization origins.

- Fourth: to make possible this work facilitates much more the education task of current and new generations in a correct way under the universal principle that bigger greatness resides in the simpler and plain tasks, carried out in a conscious and devote way. If these ancient Egyptians pyramids builders were acted not under this personal way to act universal principle, we could never achieved to see at least one of these grandiose pyramids: were Egyptian devout people and not slave people those who built it.

- Fifth: facilitates this work can be used as example to achieve a better understanding and/or explanation of all singular and mysterious constructions that exist all over the world, where the principle enunciated in the previous statement was the fundamental to carry out all these magnificent constructions and not the existence of mysterious powers or extraterrestrial techniques. Could be referred as example the cases of how were moved and placed into place the gigantic stones of Stonehegen, the Pascua islands statues or the heavy Macchu Pichu stones. The simplicity of this technique here exposed could serve as example about how to explain these mysteries, at least in a partial way.

A very specific statement that my late father and I decided to set since beginning of this theory, was the Arabic language copyrights of this work must belong to the Egyptian people freely, which we considered the least thing could be done in reconnaissance to the grandiose work made by the ancient Egyptians who built theses millenarian, perfect and enormous pyramids, those which have been surviving and will survive by thousands of years.

Personally, I consider my father would be very glad to know all these statements were stated like that.

The idea to utilize sections of pyramid layers to place the ramps was from his authorship and conception of ramps placed in a semi-detached way until top of pyramids was from my authorship. But thanks his sense of practical knowledge, his idea to utilize sections of layers to construct ramps permitted to shape definitively this theory according to factor TIME: his proposal permitted completing the conception of a technique that were enough efficient and adjusted to the conditions of the epoch, where the principal premise of architects was to get the most out of constructive capabilities regarding the time to achieve fulfill the task to build these great pyramids for Pharaohs while were alive them.

II. INTRODUCTION

Since the Napoleonic conquest, the worldwide community, led by Egyptologists, historians, archeologists, architects, engineers and various specialists of another nature, has called to decipher unfruitfully, by mean of scientific ways and another difficult to verify, how the ancient Egyptian conceived a technique to lift the heavy constructive elements that conform the pyramids of Giza plateau specially those which belong to Khufu pyramid, without at least a so elementary and rudimentary thing as wheels.

The most famous constructions of history have become object of obliged reference, in particular regarding the related about constructive matter, and at same time they have become in human greatness symbol for almost fifty centuries. Constitutes then, a challenge to decipher how Giza plateau pyramids were constructed - at same time as a great recognition to the ancient Egyptian people -, specially the one belonged to the Pharaoh Khufu or Cheops, the Greek transcription of this name.

Due to complexities that possess Cheops's Pyramid, result extremely bothersome and complex describing the totality of significant details that this construction have.

This work shows **the theory of a (new) technique of Giza plateau pyramids construction**, mainly elaborated for this work's main goal: the Khufu's pyramid. It illustrates a technique that, besides, results very difficult to ignore due its simplicity and security that shows according to the historic-social context when were built the aforementioned pyramids.

This technique is focused to explain **how the pyramid's blocks were lifted**, considering that the rest of questions and specific characteristics that possesses the pyramid have minor urgency to explain in general sense due lot of numerous explanations that exists on Internet explaining all of it - in specific, on Internet´s Web forums -, so that they do not present great repercussion and therefore does not constitute a goal: without an efficient and safe technique to lift the blocks, it is impossible to conceive an architectonic work of this magnitude.

The First type of ramps constitute the main part of this work due **it provides the effective technique to solve the incognita of how were raised all constructive elements until reach the desired 146 meters height** that had the Khufu pyramid on splendor times. The Second type of ramps provides the technique to **improve to the maximum the relation between the pyramid constructive process and the possibilities to finish it in real time** according with the constructive techniques existed on that time.

Must be mentioned this work does not include the explanation of moving and lifting big and heavy blocks of the “discharge chambers” spaces located above the roof of named “King´s chamber”, due it have been sufficiently discussed and explained in many Internet forums by this

theme´s specialists. At same time, it is necessary to mention that the processes of administration, alignment and pyramids shape construction controlling, conform the second bigger mystery locked by Giza plateau pyramids, after the blocks lifting technique explanation.

III. PYRAMIDS CONSTRUCTION BRIEF HISTORIC SUMMARY

First pyramids were built during the Ancient Empire initial stage, specifically after the Third Dynasty, when Pharaoh Djosser's reign, which ordered to forge the first pyramid: the stepped one of Sakkara. His creator was the founder of pyramidal architecture, Imhotep, to one Djosser Pharaoh put in charge to build a funerary monument in the Sakkara plateau, whom whose subsequent works were of such magnitude that gave him the merit to be reverenced as a god.

Ad hoc, Imhotep selected a specific material: limestone, abundant on the ancient Egyptian kingdom's lands. He utilized this rock blocks to erect the first pyramid, the Djosser or Sakkara stepped one, both ways it is known. It constituted the initial point to carry out great quantity of pyramids edification all over the Nile valley during successive reigns.

Subsequently, pyramids were object of deep studies accomplished by architects that received similar assignments. This originated a tendency of Pharaohs to elect the placed for the beyond cross trip like pyramid shape, according to demigods rank they showed off. Everything thanks the success reached the Imhotep's Sakkara stepped one first pyramid and subsequent development and mastery in building pyramids that posterior architects achieved. Sign of this are all pyramids that exist along Egyptian desert, many of them that stay undiscovered still nowadays. It has been checked recently with the archeological works accomplished on Sakkara's plateau funerary complex, where have been discovered new pyramids.

The maximum evidence of development attainment by ancient Egyptians on pyramids construction were that ones that compose the Giza plateau funerary complex, being Khufu's pyramid his climax, historically known with the nicknames of "The Great Pyramid", "Great Pyramid of Giza" or "The Egypt Great Pyramid", which constitutes the maximum, first and only of Ancient Seven Wonders that survives nowadays.

This pyramid, the Khufu pyramid, was the solid higher edification worldly until XIX century, before the construction of the Eiffel tower. Even nowadays, it remains as the bigger solid stonework construction.

This, the biggest and more interesting of all Egyptian pyramids and in rest of the world also, was built during the Pharaoh Khufu's reign. It is evidenced in the inside records that possess, and in the records of around the pyramids citadel of aforementioned Giza plateau, located at the outskirts of the present-day capital of Egypt, Cairo. Thank its special geographic position and unique characteristics, this pyramid is the one that calls all the attention of these construction investigators, being the more studied and venerated construction of history, besides one of Egypt principal symbols.

His proportions are so big that results too exaggerated at present, to the extent that they astound all visitors. Now possess 137 meters height, but is estimated that it should have reached 146 meters initially. His square base possess 230,20 meters edges, with 0,2 meters among four sides of maximum difference, and a 51,28 degrees nearly slope on his four faces with a leaning lightly toward the center in order to create a luminous lightning effect.

Close to 2,5 million elements composing, most of them calcareous rock almost cubic blocks of 2.5 tons average mass per cubic meter (the calcareous rock average density varies from 2,3 to 2,9 tons per cubic meter), possess an estimated about 6,5 million tons and an equivalent volume of more than 2,5 million cubic meters, deducting a rocky nucleus and inner spaces. Some elements are so heavy like the roof of King´s chamber slabs with approximately 60-80 tons and dimensions of 9 by 1 by 0,8 meters, several of them settled of in form of saddle-backed roof on the so-called "discharge chambers". It possess inner spaces like chambers, antechambers, galleries, passages and unfinished constructions as the subterranean chamber, that conform a complex and uninhabitable edification where at first sight error proofs not exists, demonstrating the specialization and complexity grade attained by builders.

Due vague ideas, we can do from Greek Herodotus's writings, it is impossible to explain if he was deceived by Egyptians to hide the technical they employ or if himself hidden it with intentional way. Or if when he arrived to Egypt ancient Egyptians agreed to forgotten the technique, perhaps following architect's orientations to protect pyramids against scrutiny or theft, or if they tried to hide it of public knowledge to propitiate a myth creation around pyramids to preserve the merit that represented dominating this technique on those times.

From all conclusions, one stands above all others: Egyptians utilized ramps to build their pyramids because proofs exist enough. In the event of Cheops's pyramid, this proof appears explicitly at the southern side where remains of ramps used exists actually, doing impossible thinking in another technique. All this without taking into account the different characteristics that shows three principal pyramids that constitute the Giza complex. For these motives, techniques unlinked with ramps have been discarded.

Renowned worldwide specialists have elaborated several theories trying to explain The Great Pyramid constructive process by using ramps, but no one has offered an answer to explain in a concise and accessible way for the epoch, the technical employee until now.

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In summarized way, it can be concluded that previous ramps theories have several critical aspects at the time to be exposed:

I- The utilization of an only external ramp with a little but extremely long and voluminous slope, proving to be impossible to implement due it doubling pyramid volume as minimum. This would imply should exist trace evidence of interaction between so huge mass and basements.

II- The implementation of an only external very steeped sloping ramp, being too risky to work, especially in the last third part of pyramid and in the pyramidion (peak) where the adherence values decreases dangerously due to the height and gravity force action.

III- The low slope spiral ramps utilization, where ramps enclose stoutly the pyramid doubling its volume. This proposal have a such enormous complexity in order to reach the pyramidion that its implementation proves to be impossible to validate because drifts into an impossible job to develop: similar to the before external ramp with a little but extremely long and voluminous slope, it should be existing evidence of interaction between this kind of ramp system mass and basements.

IV- The execution of spiral ramps with not much volume in a very little semi-detached way to the pyramid but high slopes values, something very impossible to conceive because the so risky possibilities to move constructive elements over straits, unstable and elevated slopes ramps, principally in the corners sections where adherence degree with pyramid sides proves to be extremely dangerous due talus verticality.

V- This theory modeling is similar to Uvo Hoschler's model but should not be confused with it: Mr. Uvo Hölscher theory, was somehow similar to this, but failed due not use minimal slope value in ramps - as 3.9 degrees used in this work -, and underestimate the excellent possibilities offered by using wide and solid pyramid layers sections - with a 6-meter wide minimum - to lift two or more blocks at same time at 70 meter heights where more than 89 percent of pyramid volume is built. Two characteristics these without it is impossible submit to consideration a zigzagging ramps construction theory.

All possible alternatives related with these techniques have failed, mainly when have to explain how reach the pyramidion, because their very low efficiency results, almost null guarantees for workers and minimal possibilities to accomplish complex maneuvers like required in Great Pyramid building, as example in the construction of some chambers, antechambers, the discharge chambers and conduits oriented to some space points.

IV. RAMPS EXPOSITION

The purpose of this work consists on presenting in a satisfactory way and adequate to possibilities of that time, a technique that facilitates expose in a valid way and feasible, the employ of safe ramps to build Giza plateau pyramids. It is a goal tries to demonstrate a possibility to fulfill the building of such magnitude task, especially with the objective to reach the pyramidion or peak at 146 meters height, by means of extensive use of zigzagging ramps technique, with minimal 3.9 degrees slope and small dimensions compared with pyramid measures.

With this purpose, a technique that outlines the use of two types of ramps is exposed:

- The first ones placed in a semi-detached way on the spaces on each layer steps to implement zigzagging ramps over them, denominate of First type in forward, which stands out of layers edges on the upper pyramid third, supported by talus with 65 degrees slope lateral walls that permit create a path to move all constructive elements to reach the pyramidion in a safe and satisfactory way (Figure 1).

- The second ones, made in zigzagging way also, by using section of the pyramid layers, in forward denominate of Second type, so that the same pyramid serves as support to build these ramps (Figure 2).

The fundamentals used to outline this theory are based in the following premises:

The model elaboration was made taking approximate dimensions that have blocks that compound the pyramids – Khufu pyramid more precisely -, utilizing geometric basic forms, physics-mathematical simple reasoning and measures of common lengths of epoch. A suitable angle for the slope must be determined to make possible annulling almost completely the action of gravity force, to obtain a ramp that satisfies two fundamental conditions:

I- Transform the moving blocks work to overcome only the friction force when dragging them and not into overcome the action of gravity force over them.

II- Facilitate to move the blocks in a comfortable, safe and fast way, making possible to accomplish complex maneuvers with a minimum risk; even when it implies hauling over bigger distances and to transfer lot of elements that compose ramps and talus also.

For the case of model ramp made as pattern to determine the slope angle, the measures were obtained by means of certain calculus employing the biblical cubit as longitude (considering the use of this cubit in this work originally due lack of knowledge), obtaining the following results:

- Initial height: 0.45 meters (1 cubit)
- Final height: 2.70 meters (6 cubits, including initial height)
- Ramp longitude: 33.75 meters (75 cubits)
- Width (optional): 1.8 meters (4 cubits)

By means of the **Pythagoras´s right-angled triangle** theorem**,** were obtained the slope angle that will have the ramps, obtaining the desired result. It is made in very random process: not specific procedures were used to calculate the slope. These calculus appear in the Appendix tables, where, besides, can be observed the method to design different longitude ramps accordingly the previously outlined.

This allows define five distinctive features of this theory regarding previous ones, those that constitute complete new concepts:

I- The small dimensions ramps possesses regarding the pyramid, and the almost horizontal slope angle ramps possesses 3.9 degrees.

II- The space that this theory is developed constitutes the steps and certain fixed sections over the edges of the pyramid layers.

III- The First type ramps, the semi-detached way disposed, deploy ramps and rest platforms, placed over the talus system, which vary dimensions according to the height and type of elements to rise. This facilitates use these ramps in a semi-detached way and separate of faces at the same time, which frees them of the layer where are placed since are completely separate from steps.

IV- The Second type ramps use small sections of layer edges that increase in length and depth on layers as ramps and pyramid construction advance, according dimensions have to take the same. This strengthens at maximum the ramps structures because their bases are built with the pyramid body, and in their top end uses layer´s sections to deploy comfortable rests of wide dimensions to allow accomplish constructive complex maneuvers.

V- In the case of First type ramps, the core of ramps talus system, and consequently those materials that make the ramps slope, is composed by calcareous rocks, which provides top stability to the system, and the talus walls are made with limestone chips, gypsum, and a calcareous clay mortar - called "Tafla" -, and vegetable fiber, all these which give a very high stability to the ramps system.

The possibilities these ramps have, taking into account the minimum exploitation possibilities could bring, provide a group of advantages that results difficult to reach by previous theories:

- The almost horizontal levels use with very minimal 3,9 degrees slopes, and little dimensions in relation to the pyramids: the base edges of pyramid present a 230 meter length and average ramps suggested in this work have between 20 and 70 meters, as can be appreciated in the Appendix tables. It provides effectiveness with no comparison regarding previous theories: **provides total efficiency in order to ramps system building, maintaining and exploitation**.

- Although logics indicates big ramps implementation, **the intern ramps of this work (the Second type ones) prove to be ideal to accelerate the constructive process, being very effective and productive for the layers of lower two third's pyramid volume case, where more than 89 percent of pyramid´s body volume is built**.

- The external ramps, **the First type ones, placed in a semi-detached way over the layers edges in one of the pyramid faces and sticking over the pyramid tallest layers, would be used to refill the spaces occupied by the inner ramps - the Second type ones -, to place the finishing casing stones of faces, and specially in order to construct the topmost part: the piramidion**. If are semi-detached correctly **can conform a kind of plateau on the Pyramid Peak to work comfortably**. This grants total **effectiveness in relation to the difficult theme of explaining how to reach the upper part of pyramid**: the most conflictive stage (Figure 3).

It is necessary to make the following statements:

- First: it could be thought that using the four faces of the pyramid in unison, with First type ramps distributed over the first third layers, with the precise work group men, it would be advantageous to carry out the construction of the pyramid. But this would complicate too much the constructive process due could be very difficult to keep the organization and the original constructive design without suffering interferences due to the ramps overlapping work.

- It **can be accelerated the blocks lifting when working with the Second type ramps by means of intense work with hauling animals: specially with oxen**. This may be possible due Second type ramps are built on completely solid and stable bases: the pyramid body itself.

- Second: if a calculation is carried out by keeping in mind the minimum possibilities that bring the Second type ramps, **it is possible to calculate that two blocks can be hauled in unison by means these Second type ramps use**. Considering the lost time to cover the ramps and resting spaces distances, and stops between ramps, can be obtained as result that can be hauled 2 blocks at same time per minute, which adjusts to the minimal parameters demanded by experts in order that ramp systems result efficient: two blocks at the same time as mínimum. **To achieve this effectiveness is necessary to make good use of 6 meters wide that possess these ramps type (possible to use amply until 71.6 meters of height, above the second third of pyramid volume), that could permit haul 2 blocks at**

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same time for each ramp: can be hauled constantly, one group after other, without fear suffer accidents thanks to the stability and reliability when working on almost horizontal surfaces built on the pyramid body (Figures 4 & 6).

- Third: **blocks were transported by wooden sledge likely, lubricated slightly by watered oil** (Löhner: 2018).

- Fourth: according with Wikipedia information, experiments done with blocks weighing 2.5 tons, showed that 18 men could drag this block over a 1-in-4 incline ramp (higher than exposed on this papers: 1-in-6), at a rate of 18 meters per minute. Several experiments indicate ancient Egyptians could have worked using this kind of stones. **Egyptologists generally accept this for the 2.5 tons blocks mostly used but do not agree over the methods used for the more than 15 tons and several 70 to 80 tons blocks** (Wikipedia: 2018). Nevertheless **there is a lot of information on Internet provided by engineers that studying pyramids showing various method to elevate blocks of this weigh by working processes made by large groups of strong men specialized in been using levers and thick ropes**, destined to do this with these heavy blocks with all necessary resources along time each level were made.

All this **without discard all previous theories could have validity for the case to execute secondary maneuvers** of some kind along the constructive process, complementing the here exposed technique. Somewhat results logical to understand due Great pyramid constructive task complexity.

- Must be clarified that in the first layers of the first third, the more logic, safe and economic decision consists in **accelerate the process by implementing an initial ramp of big dimensions**, just as appears in the figures and afterwards continues with the mentioned inner or Second type ramps. **This affirmation appears suggested in several Internet forums for numerous engineers that study pyramids**.

- Should be taken into account that after finished the Second type ramps use, all of it must be demolished at same time started the construction of talus to support the First type ramps. Consequently, the initial big ramp used to subsequently place the Second type ramps to build the main body percentage volume, must be demolished due erosion process subjected. And in the other edge corner should be started a similar one other to build the First type ramp's talus to allow higher elements traffic to finish the upper pyramid section and place case stones on time, but cannot be used this primary initial big ramp in order to concede time to dismount all Second type ramps, also.

V. TALUS SYSTEM STABILITY STUDY: GREAT PYRAMID PARTICIPANT FORCES ANALYSES (*BY CIVIL ENG. JUAN DIEGO ARANDA Y.*)

To start, there is a pyramid of certain X- mass, with an elasticity module considering the calcareous rock and 6 layers separated. Moreover, a pseudo acceleration diagram of the pertinent area is given.

First, a basic analysis of earthquake-proof is made, modeling a pyramid in a 1 degree of freedom system to calculate the generalized masses (M) and the participating masses (L) of the structure.

By means of the flexibility method the necessary matrix is calculated, and together with the forces (that will be assumed for the weight by floor), to find the movement by layer, it is found the structure vibration mode and the natural model shape value.

Then, it is calculated the whole pyramid vibration period together with the obtained data, and the value for the previously calculated period is found in the pseudo acceleration chart, making possible that the pyramid forces by floor can be found.

Finally, six forces are obtained to check the factors of slip and tumble to verify the stability of the walls of the pyramid and the system of slopes finally, together the total weight of the construction (Figure 5).

VI. CONCLUSIONS

It is effective and productive to have a technique like this that permits maneuver without big efforts nor hazards, and at same time facilitates raise bigger quantity of blocks respect time, even when dimensions of ramps increase directly proportional with height.

These conclusions permit discern that these small dimension and volume ramps, constitute the more advantageous and safe variant, resulting almost impossible to refuse in case of this kind of construction: it facilitates to carried out in an efficient way great number of small scale works into a great work as results these pyramids construction, by compensating the magnitude of the work that must be done.

Moreover, permits conceive works with the complexity required in a reliable and safe way, without exposing the workers to any kind of risks: minimize the difficulties, and construction can be executed without contretemps and setbacks.

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By this way, it is possible to decide what type of ramps to use, in what moments, which are necessary dimensions of it for the stage are running constructive process, how to place it, how much constructive elements raise for every ramp regarding availability of manual labor, etcetera.

Even when it is necessary this theory validity must be demonstrated by the world main experts to be classified as "possible theories", results comprehensible the practical advantage that offers to carry out the possibility of analyze, design and afterwards accomplish a work of the magnitude as the Giza plateau pyramids when taking a such of technique.

This theory could permit Pharaohs have an effective technique, adjusted to that epoch existent knowledge, to begin conceiving, designing and deploying a kind of construction like this: it would permit carry out the simulation by means of a scale model, the totality of the constructive processes and analyze carefully all details to determine with accuracy all constructive stages, besides facilitating to accounts with certain possibility degree when uncalculated problems arise. All this thanks that may counts with a plain and safe technique that permits to analyze in a specific and carefully way all constructive details.

This hypothesis permits imagine in a reasonable way the probable destination had the minimum evidences that builders leave of used ramps to build these three bigger pyramids of Giza plateau, because could be retired totally due their small dimensions. At best could be existing ramps remains, buried below the blocks were placed in the locations it occupied on pyramids.

If this theory reach the necessary validity, it would allow from the technical point of view redefine the enigma of Giza pyramids construction, guiding the researches focused to discovering how pyramids was calculated and designed and how all its pieces and sections were elaborate, placed and built.

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FIGURES

Note: all figures can be enlarge

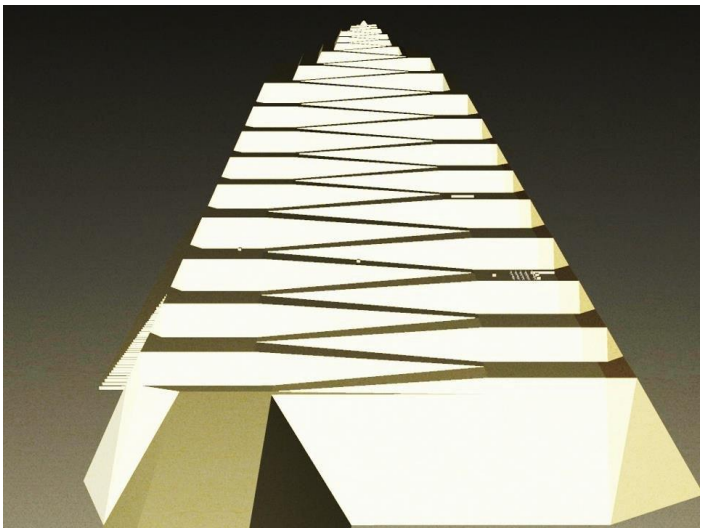

Figure 1: First type ramps

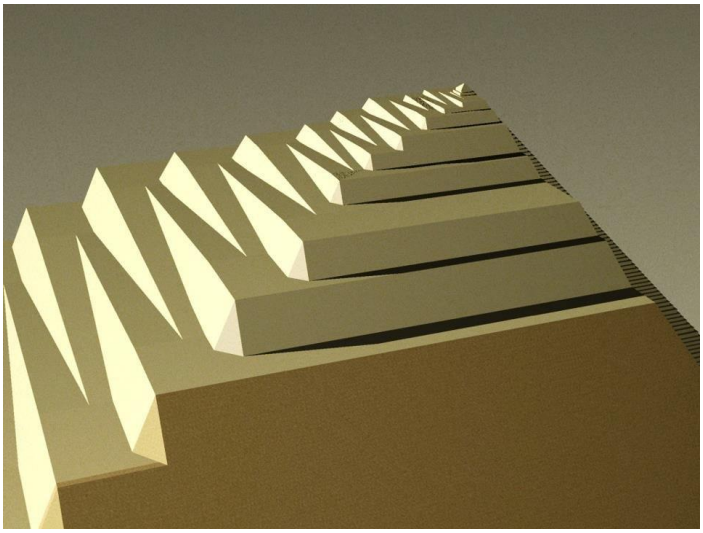

Figure 2: First type ramps (cont.)

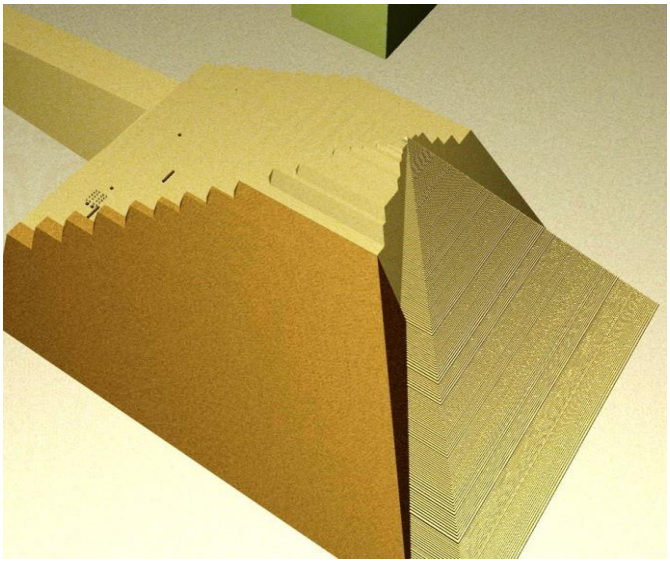

Figure 3: First type ramps (cont.)

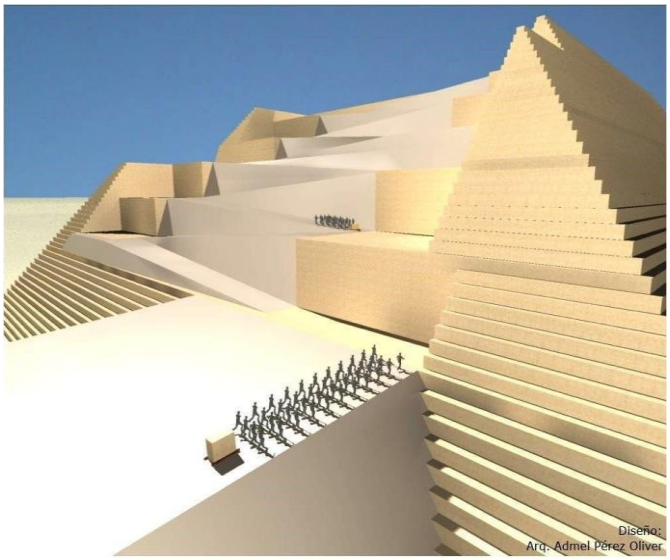

Figure 4: Second type ramps

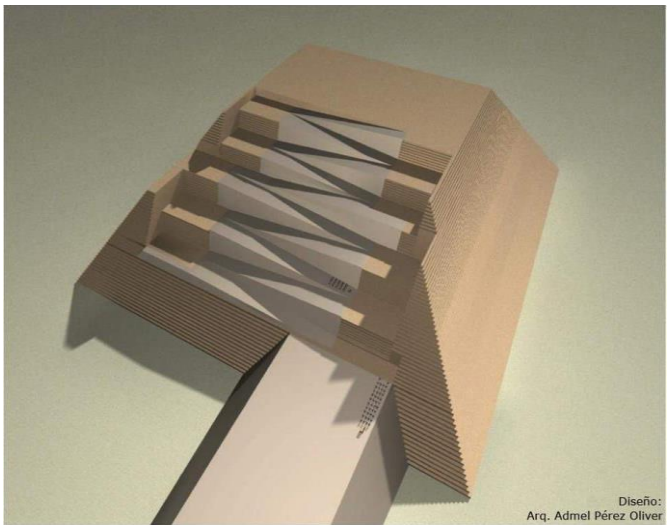

Figure 5: Second type ramps (cont.)

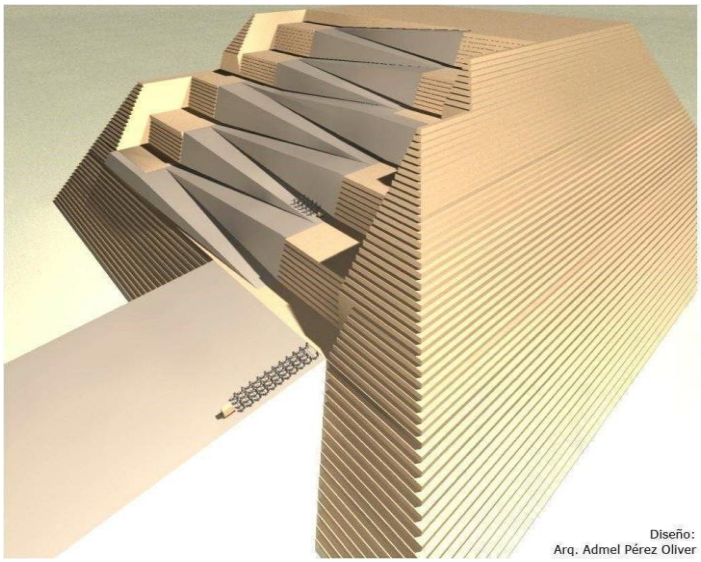

Figure 6: Second type ramps (cont.)

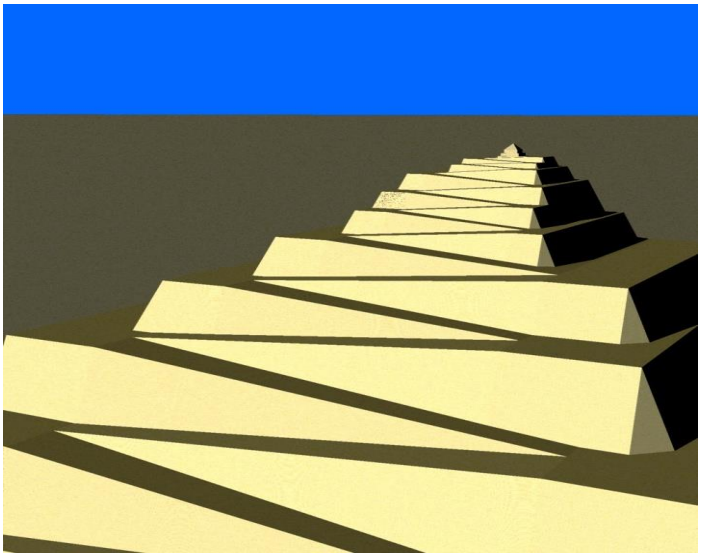

Figure 7: First type ramps details

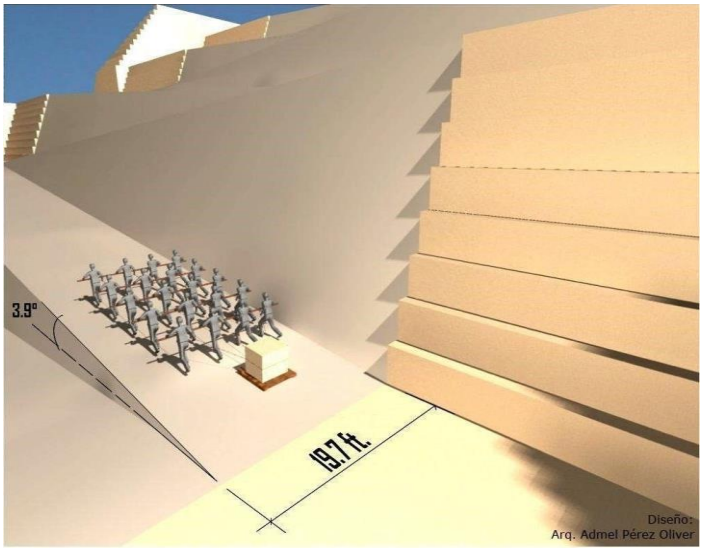

Figure 8: Second type ramps details

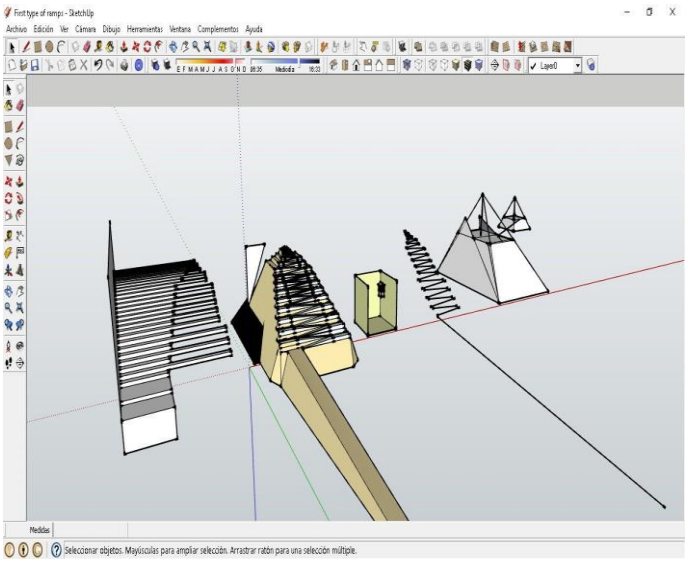

Figure 9: First type ramps design ambience

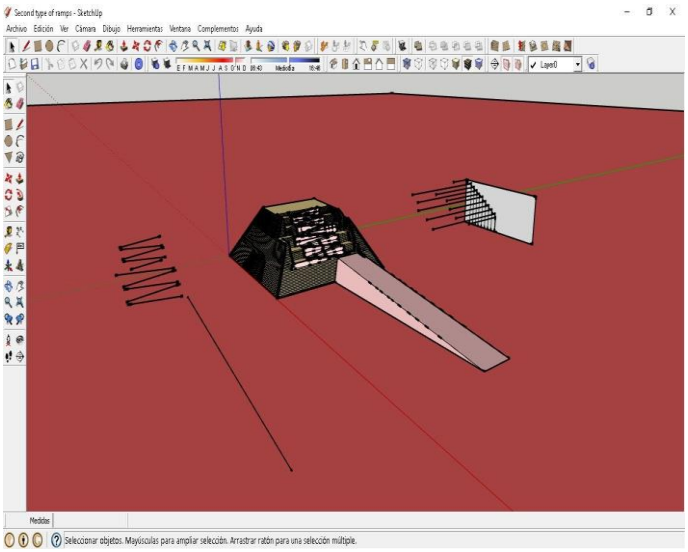

Figure 10: Second type ramps design ambience

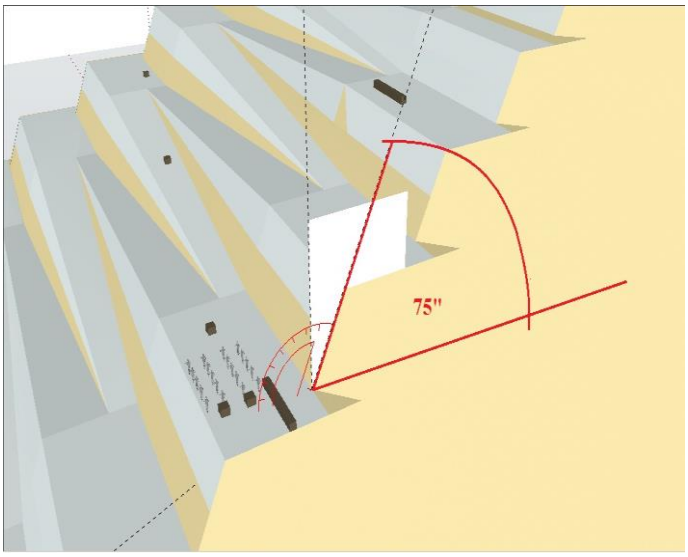

Figure 11: Sectional slope angle for talus that compounds ramps

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ANNEXES

Annex A:
Model ramp parameters calculus:
- Parameters:

Initial ramp height (h1):	0.4500 meters
Final ramp height (h2):	2.7000 meters
Ramp length (L):	33.7500 meters
Ramp width (A):	1.8000 meters

A.1.: Formula to find the slope angle:
Angle (?):
Cot (?) = (L / (h2-h1))
Cot (?) = 1 / tan (?)= 15.0000
(?) = 3.9054

Annex B:

Table for ramps calculus:
N-cubits height calculus, related with ramps length, regarding slope angle (3.9 degree), taking into account that total height does not include A1 (0.45 meter):
Formula:
Length (L) = h2 / Cot (angle?)

Calculus to determine the height until which ramps can be used (H):
H = N / D
Where:
N = (230.4/2) * (L/2)
D = 146.6/(230.4/2)

Results table:

Measures: height (h2)	Height (h2)	Length (L)	Pyramid height (H)
1 cubit	0,45 meters	6,6008 meters	82,6697 meters
2 cubits	0,90 meters	13,2017 meters	80,2314 meters
3 cubits	1,35 meters	19,8025 meters	77,7931 meters
4 cubits	1,80 meters	26,4034 meters	75,3548 meters
5 cubits	2,25 meters	33,0042 meters	72,9165 meters
6 cubits	2,70 meters	39,6050 meters	70,4782 meters
7 cubits	3,15 meters	46,2059 meters	68,0399 meters
8 cubits	3,60 meters	52,8067 meters	65,6016 meters
9 cubits	4,05 meters	59,4075 meters	63,1633 meters
10 cubits	4,50 meters	66,0084 meters	60,7250 meters
11 cubits	4,95 meters	72,6092 meters	58,2867 meters
12 cubits	5,40 meters	79,2101 meters	55,8484 meters

Note: ramp widths begin from a minimal width equivalent to doubled width of object to be transported.

Appendix C:

Table for talus walls sliding:

Note: the Internal Friction Angle is related with the angle of repose or possible maximum angle for slope of granular materials. Internal friction angle depends on of the angle of repose, which is determined by internal friction, cohesion values and particles shape:

Values of Internal friction angle in some materials (founded on remnants of the pyramid construction ramps):

Chalk soil:	45 degrees
Dry clay:	25 – 40 degrees
Dry sand:	34 degrees
Wet sand:	45 degrees
Gravel:	30 – 45 degrees
Slabs:	56 – 75 degrees (According granular shape: if not rounded but standing vertically tablet style)

Values of Cohesive strength:

Rock:	10,000 KPa
Medium clay:	96 – 192 KPa

Note:
The analysis of the system stability by mean of this material study has to be proven in situ by experts and archaeologist, which in before consults on Internet have demonstrated that the talus systems would have composed by these elements.

Annex D: Talus system stability study. Pyramid participant forces analyses

SUPPORT TALUS PIRAMYD CALCULUS

	From structure													
	FLOOR	Mass	Weight (ton)	[Q](ton)	E (ton/m^2)	4,428,929.39								
	1	234,556.5749	2,301,000.00	2,301,000.00	h1	20	[F]LatPi (m^2/ton)	602.10	1505.25	2408.41	3311.56	4666.29	6278.42	
	2	186,442.4057	1,829,000.00	1,829,000.00	h2	20		1,505.25	4,816.81	8,429.43	12,042.04	17,460.95	23,909.47	
	3	114,271.1519	1,121,000.00	1,121,000.00	h3	20		2,408.41	8,429.43	16,256.75	24,385.13	36,577.69	51,086.84	xInertia^-1x10^-6
	4	36,085.6269	354,000.00	354,000.00	h4	20		3,311.56	12,042.04	24,385.13	38,534.52	60,210.19	86,004.23	
	5	21,651.3761	212,400.00	212,400.00	h5	30		4,666.29	17,460.95	36,577.69	60,210.19	100,174.70	148,941.56	
	6	8,419.9796	82,600.00	82,600.00	h6	35.7		6,278.42	23,909.47	51,086.84	86,004.23	148,941.56	232,786.96	

	[F]X[Q]=[D]													
	PISO	[D](m)	Φ	L*(ton*s^2/m)	M*(ton*s^2/m)	T (s)	Inertia Forces (ton)	FS slide	FS Turn				I (m^4)	
	1	0.000659	0.04839538	116,370.16	42,737.95	0.142	95,816.71	6.006489169	10.3573233				14,448,725.18	
	2	0.002192	0.16097525		L*/M*	Sa(cm^2/s)	253,334.00	**Accomplish?**						
	3	0.004139	0.30395828		2.7228767	**310**	293,184.00							
	4	0.006265	0.46008665				140,140.47	**YES**	**YES**					
	5	0.009591	0.70434016				128,723.44							
	6	0.013617	1				71,072.36							

														Values for Cairo	
							<----------	**71,072.36**						**TR**	**Sa(cm^2/s)**

								<----------	**128,723.44**					**2475**	**310**	
														975	**220**	
					Wtotal				<----------	**140,140.47**				**475**	**180**	
														72	**90**	
					5,900,000.00					<----------	**293,184.00**					
											<----------	**253,334.00**				
												<----------	**95,816.71**			
	Wfloor 0															

[F]LatPi (m^2/ton)	0.000041672	0.000104179	0.000166687	0.000229194	0.000322955	0.000434531		
	0.000104179	0.000333373	0.000583403	0.000833433	0.001208477	0.001654780		
	0.000166687	0.000583403	0.001125134	0.001687701	0.002531551	0.003535733	x10^-6	
	0.000229194	0.000833433	0.001687701	0.002666984	0.004167163	0.005952375		
	0.000322955	0.001208477	0.002531551	0.004167163	0.006933117	0.010308284		
	0.000434531	0.001654780	0.003535733	0.005952375	0.010308284	0.016111245		

Annex E: Oxen hauling calculus

HAULING CALCULUS FOR 4 and 8 OXEN CREW OVER 6 METERS WIDHT RAMPS:

Ox characteristics:	**Value:**	**Unit:**		**Force of 4 Oxen crew hauling one 2.5 Tons limestone Block:**	
Power (minimal force per Ox):	**1,000.00**	N (av.: 10 % ox weight) *		**4,000.00**	N (1 Ox * 4)
Speed (minimal velocity per Ox):	**1.00**	m/s (av.: to be constant) *		**1.00**	Velocity: m/s (average: to be constant)
Lenght (per Ox):	**2.500**	m (average) *		**8.500**	Lenght: m (1st_Ox+0.5_spread+2nd_Ox+1_hauling_mechanism+2_Meter_Block-average)
Width (per Ox, average):	**1.000**	m (average) *	*(2 Ox couple)->*	**2.500**	Width: m (left_Ox+0.5_spread+right_Ox)
2,5 Tons Hauling Force needed:	**2,521.89**	**N (for average stones weight)**			
			Area of Oxen crew:	**21.250**	**m2 (for a 4 Oxen crew)**

*: All oxen data: Wikipedia (en.wikipedia.org)

Note: the 4 Oxen crew is necessary due with just 2

cannot be hauled a 2.5 Tons block, besides 4 Oxen

could make possible a higher hauling force if needed

Force of 8 Oxen crew (couple of 4 Oxen crew aside) hauling two 2.5 Tons limestone Block:	
8,000.00	N ((1 Ox * 4) * 2)
1.00	Velocity: m/s (average: to be constant)
8.500	Lenght: m (1st_Ox+0.5_spread+2nd_Ox+1_hauling_mechanism+2_Meter_Block-average)
5.500	Width: m ((left_Ox+0.5_spread+right_Ox)+(0.5_spread)+(left_Ox+0.5_spread+right_Ox))

Area of Oxen crew:	**46.750**	**m2 (for an 8 Oxen crew)**
(4 each by side in forward)+(4 each by side in backward)=giving an Eight Oxen crew		

POSSIBLE DUE THIS RAMPS ROBUSTNESS AND STABILITY: ARE PART OF PYRAMID CORE

and RAMPS ARE MINIMAL 6 METERS WIDTH

Great Pyramid useful construction data:

20 Years (minimal) to seconds:	**630,720,000.00**	**s (seconds)**
Elements Quantity (approx.):	**2,300,000.00**	**unit**
Mass Quantity (approx.):	**6,436,167.97**	**Tons**
Final height:	**146.000**	**m (meters)**

Second per elements quantity (average):	
274.23	**Seconds / Elements**
4.57	**Minutes / Elements**

Using oxen in the second type ramps:

Total of pieces until 77.87 meters (more than Fh):	**2,066,251.86**	pieces
Total lenght of ramps:	**1,055.504**	m (meters)

Annex E: Oxen hauling calculus (cont.)

Using 8 oxen crew: how many blocks per day can be hauled on each 2nd. Type ramps? Note: ramps increase height according courses construction						(Hauling)+(Return and resting steeps) time: (t) * 2.5 times	Taking into account the (hauling, resting steeps, return and final course construction's complications) times				
Quantity of blocks per minutes:	2	blocks (2.5 Tons)	Without taken into account the resting steeps								
Speed (minimal value) of oxen:	1	m/s	Hauling time (s):	Hauling t (min.):	Hauling t (hour):						
Initial ramp lenght:	352.861	m (lenght)	352.86	5.88	0.10	0.25	Unnecessary for this ramp: 50 m width		2 blocks oxen hauling		
Ramp 1 lenght:	79.350	m (lenght)	79.35	1.32	0.02	0.06	199.62	Hauling times / day	* 2 =	399.24	Blocks / day
Ramp 2 lenght:	76.453	m (lenght)	76.45	1.27	0.02	0.05	207.19	Hauling times / day	* 2 =	414.37	Blocks / day
Ramp 3 lenght:	76.396	m (lenght)	76.40	1.27	0.02	0.05	207.34	Hauling times / day	* 2 =	414.68	Blocks / day
Ramp 4 lenght:	76.396	m (lenght)	76.40	1.27	0.02	0.05	207.34	Hauling times / day	* 2 =	414.68	Blocks / day
Ramp 5 lenght:	86.766	m (lenght)	86.77	1.45	0.02	0.06	182.56	Hauling times / day	* 2 =	365.12	Blocks / day
Ramp 6 lenght:	48.518	m (lenght)	48.52	0.81	0.01	0.03	326.48	Hauling times / day	* 2 =	652.95	Blocks / day
Ramp 7 lenght:	64.691	m (lenght)	64.69	1.08	0.02	0.04	244.86	Hauling times / day	* 2 =	489.71	Blocks / day
Ramp 8 lenght:	64.691	m (lenght)	64.69	1.08	0.02	0.04	244.86	Hauling times / day	* 2 =	489.71	Blocks / day
Ramp 9 lenght:	64.691	m (lenght)	64.69	1.08	0.02	0.04	244.86	Hauling times / day	* 2 =	489.71	Blocks / day
Ramp 10 lenght:	64.691	m (lenght)	64.69	1.08	0.02	0.04	244.86	Hauling times / day	* 2 =	489.71	Blocks / day
			Total time (s):	Total time (min.):	Total time (hour):	Total t. (hour):				4,619.90	Blocks / day
			1,055.50	17.59	0.29	0.73					