

Table 3 - Transport Lanes

This table determines the **maximal values for the transport lanes per level**.

The number of transport lanes is a measure of the **overall system's performance factor**. This directly leads to the second key figure: the number of installed blocks per day.

On average over the year, there were 7 transport lanes at ground level and only 1 lane near the pyramidion.

Until the second turn of the wide ramp or the construction of level 59, the wide ramp could be built to any desired width, as it did not collide with any other ramp path. During this phase, there were sufficient transport lanes, and the project was limited only by the maximum number of 20,000 workers, i.e., it was **capacity-limited**.

As the pyramid grew taller and the space became increasingly narrow, all the single lanes had to end at different heights. From the second turn of the wide ramp, the project was limited by the maximum number of physically possible transport lanes, i.e., it was **space-limited**.

There is an [analysis and a diagram](#) at the end of this document.

Level No.	The Level Number counts the levels from the bottom to the top (1 - 210).
Property	Special property of the level, i.e. medium.
Workers total one lane	Number of workers required to operate a fully staffed delivery lane. These values are determined in Table 2 and adopted here.
Total lanes	Number of lanes that physically reach the corresponding level. This number is decreasing with the height of the pyramid. These values are determined in Table 1 and adopted here.
Delivery lanes	Number of physically existing tracks that could be used for the transport of stone blocks. Since the way back was a separate lane, the following condition holds for the delivery lanes: $L_1 = \text{Total_lanes} - 1$

Maximum
transport lanes

Represents the maximum number of transport lanes during the 3 months of the Nile flood, if 20,000 workers were available.

$$L_2 = 20,000 / \text{Workers_total_one_lane}$$

But this number cannot be larger than the physical *Delivery_lanes*. Therefore, the value for the *maximum transport lanes* is determined by the minimum of the two values L_1 and L_2 :

$$L_3 = \min(L_1, L_2)$$

This number is workers-limited and space-limited.

Minimum
transport lanes

Represents the maximal number of transportation lanes during the 9 months outside the Nile flood, if 10,000 workers were available.

$$L_4 = 10,000 / \text{Workers_total_one_lane}$$

But this number cannot be larger than the physical *Delivery_lanes*. Therefore, the value for the *minimum transport lanes* is determined by the minimum of the two values L_1 and L_4 :

$$L_5 = \min(L_1, L_4)$$

This number is workers-limited and space-limited.

Average
transport lanes

Average of the transport lanes over the year.

$$L_6 = (3 * L_3 + 9 * L_5) / 12$$

Average blocks / day

Represents the average of installed blocks per day over the year. 144 blocks are quarried, transported, and installed each working day.

$$\text{Average_blocks/day} = \text{Average_transport_lanes} * 144$$

Average blocks
/ minute

Represents the average of installed blocks per minute over the year. 144 blocks are quarried, transported, and installed each working day.

$$\text{Average_blocks/minute} = \text{Average_blocks/day} / (12 * 60)$$

Level No.	Property	Workers total one lane	Total lanes	Delivery lanes	Maximal transport lanes	Mininmal transport lanes	Average transport lanes	Average blocks /day	Average blocks /minute
1	Bottom, 1st round	1,804	13	12	11.09	5.54	6.93	998	1.39
2		1,827	13	12	10.95	5.47	6.84	985	1.37
3		1,849	13	12	10.82	5.41	6.76	973	1.35
4		1,871	13	12	10.69	5.34	6.68	962	1.34
5		1,894	13	12	10.56	5.28	6.60	950	1.32
6		1,916	13	12	10.44	5.22	6.52	939	1.30
7		1,939	13	12	10.32	5.16	6.45	928	1.29
8		1,961	13	12	10.20	5.10	6.37	918	1.27
9		1,984	13	12	10.08	5.04	6.30	907	1.26
10		2,006	13	12	9.97	4.99	6.23	897	1.25

Table 3 – Transport Lanes /3

Level No.	Property	Workers total one lane	Total lanes	Delivery lanes	Maximal transport lanes	Mininmal transport lanes	Average transport lanes	Average blocks /day	Average blocks /minute
11		2,028	13	12	9.86	4.93	6.16	887	1.23
12		2,051	13	12	9.75	4.88	6.10	878	1.22
13		2,073	13	12	9.65	4.82	6.03	868	1.21
14		2,096	13	12	9.54	4.77	5.96	859	1.19
15		2,118	12	11	9.44	4.72	5.90	850	1.18
16		2,140	12	11	9.34	4.67	5.84	841	1.17
17		2,163	12	11	9.25	4.62	5.78	832	1.16
18		2,185	12	11	9.15	4.58	5.72	824	1.14
19		2,208	12	11	9.06	4.53	5.66	815	1.13
20		2,230	12	11	8.97	4.48	5.61	807	1.12
21		2,252	12	11	8.88	4.44	5.55	799	1.11
22		2,275	12	11	8.79	4.40	5.49	791	1.10
23		2,297	12	11	8.71	4.35	5.44	784	1.09
24	North entrance	2,320	11	10	8.62	4.31	5.39	776	1.08
25		2,342	11	10	8.54	4.27	5.34	769	1.07
26		2,365	11	10	8.46	4.23	5.29	761	1.06
27		2,387	11	10	8.38	4.19	5.24	754	1.05
28		2,409	11	10	8.30	4.15	5.19	747	1.04
29		2,432	11	10	8.22	4.11	5.14	740	1.03
30		2,454	11	10	8.15	4.07	5.09	733	1.02
31		2,477	11	10	8.08	4.04	5.05	727	1.01
32		2,572	11	10	7.78	3.89	4.86	700	0.97
33	1st corner	2,594	10	9	7.71	3.85	4.82	694	0.96
34		2,617	10	9	7.64	3.82	4.78	688	0.96
35		2,639	10	9	7.58	3.79	4.74	682	0.95
36		2,661	10	9	7.00	3.76	4.57	658	0.91
37		2,684	10	9	7.00	3.73	4.54	654	0.91
38		2,706	10	9	7.00	3.70	4.52	651	0.90
39		2,729	10	9	7.00	3.66	4.50	648	0.90
40		2,751	10	9	7.00	3.64	4.48	645	0.90
41		2,773	10	9	7.00	3.61	4.45	641	0.89
42		2,796	10	9	7.00	3.58	4.43	638	0.89
43	Vol. 50%	2,818	10	9	7.00	3.55	4.41	635	0.88
44		2,841	10	9	7.00	3.52	4.39	632	0.88
45		2,863	9	8	6.99	3.49	4.37	629	0.87
46		2,885	9	8	6.93	3.47	4.33	624	0.87
47		2,908	9	8	6.88	3.44	4.30	619	0.86
48		2,930	9	8	6.83	3.41	4.27	614	0.85
49		2,953	9	8	6.77	3.39	4.23	610	0.85
50		2,975	9	8	6.72	3.36	4.20	605	0.84
51		2,998	9	8	6.67	3.34	4.17	600	0.83
52		3,020	8	7	6.62	3.31	4.14	596	0.83
53		3,042	8	7	6.57	3.29	4.11	592	0.82
54		3,065	8	7	6.53	3.26	4.08	587	0.82
55		3,087	8	7	6.48	3.24	4.05	583	0.81
56		3,110	7	6	6.00	3.22	3.91	563	0.78
57		3,132	7	6	6.00	3.19	3.89	561	0.78
58		3,154	7	6	6.00	3.17	3.88	558	0.78
59		3,177	7	6	6.00	3.15	3.86	556	0.77
60	2nd corner	3,272	6	5	5.00	3.06	3.54	510	0.71

Table 3 – Transport Lanes / 4

Level No.	Property	Workers total one lane	Total lanes	Delivery lanes	Maximal transport lanes	Mininmal transport lanes	Average transport lanes	Average blocks /day	Average blocks /minute
61		3,294	6	5	5.00	3.04	3.53	508	0.71
62		3,317	6	5	5.00	3.01	3.51	506	0.70
63		3,339	6	5	5.00	2.99	3.50	503	0.70
64		3,362	6	5	5.00	2.97	3.48	501	0.70
65		3,384	6	5	5.00	2.96	3.47	499	0.69
66		3,406	6	5	5.00	2.94	3.45	497	0.69
67		3,429	6	5	5.00	2.92	3.44	495	0.69
68		3,451	6	5	5.00	2.90	3.42	493	0.68
69		3,474	6	5	5.00	2.88	3.41	491	0.68
70	Height 1/3	3,496	6	5	5.00	2.86	3.40	489	0.68
71		3,518	6	5	5.00	2.84	3.38	487	0.68
72		3,541	6	5	5.00	2.82	3.37	485	0.67
73		3,563	6	5	5.00	2.81	3.35	483	0.67
74		3,586	6	5	5.00	2.79	3.34	481	0.67
75		3,608	6	5	5.00	2.77	3.33	479	0.67
76		3,631	6	5	5.00	2.75	3.32	477	0.66
77		3,653	6	5	5.00	2.74	3.30	476	0.66
78		3,675	6	5	5.00	2.72	3.29	474	0.66
79		3,698	6	5	5.00	2.70	3.28	472	0.66
80		3,720	6	5	5.00	2.69	3.27	470	0.65
81		3,743	6	5	5.00	2.67	3.25	469	0.65
82	3rd corner	3,838	6	5	5.00	2.61	3.20	461	0.64
83		3,860	6	5	5.00	2.59	3.19	460	0.64
84		3,883	6	5	5.00	2.58	3.18	458	0.64
85		3,905	6	5	5.00	2.56	3.17	457	0.63
86		3,927	6	5	5.00	2.55	3.16	455	0.63
87		3,950	6	5	5.00	2.53	3.15	453	0.63
88		3,972	5	4	4.00	2.52	2.89	416	0.58
89		3,995	5	4	4.00	2.50	2.88	414	0.58
90		4,017	5	4	4.00	2.49	2.87	413	0.57
91		4,039	5	4	4.00	2.48	2.86	411	0.57
92		4,062	5	4	4.00	2.46	2.85	410	0.57
93		4,084	5	4	4.00	2.45	2.84	408	0.57
94		4,107	5	4	4.00	2.44	2.83	407	0.57
95		4,129	5	4	4.00	2.42	2.82	406	0.56
96		4,152	5	4	4.00	2.41	2.81	404	0.56
97		4,174	5	4	4.00	2.40	2.80	403	0.56
98		4,196	5	4	4.00	2.38	2.79	401	0.56
99		4,219	5	4	4.00	2.37	2.78	400	0.56
100		4,241	5	4	4.00	2.36	2.77	399	0.55
101		4,336	5	4	4.00	2.31	2.73	393	0.55
102	2nd round	4,359	5	4	4.00	2.29	2.72	392	0.54
103		4,381	5	4	4.00	2.28	2.71	391	0.54
104		4,404	5	4	4.00	2.27	2.70	389	0.54
105	Median	4,426	5	4	4.00	2.26	2.69	388	0.54
106		4,448	5	4	4.00	2.25	2.69	387	0.54
107		4,471	5	4	4.00	2.24	2.68	386	0.54
108		4,493	5	4	4.00	2.23	2.67	384	0.53
109		4,516	5	4	4.00	2.21	2.66	383	0.53
110		4,538	5	4	4.00	2.20	2.65	382	0.53

Table 3 – Transport Lanes / 5

Level No.	Property	Workers total one lane	Total lanes	Delivery lanes	Maximal transport lanes	Mininmal transport lanes	Average transport lanes	Average blocks /day	Average blocks /minute
111		4,560	5	4	4.00	2.19	2.64	381	0.53
112	Vol. 90%	4,583	5	4	4.00	2.18	2.64	380	0.53
113		4,605	5	4	4.00	2.17	2.63	379	0.53
114		4,628	5	4	4.00	2.16	2.62	377	0.52
115		4,650	5	4	4.00	2.15	2.61	376	0.52
116		4,672	4	3	3.00	2.14	2.36	339	0.47
117		4,768	4	3	3.00	2.10	2.32	335	0.46
118		4,790	4	3	3.00	2.09	2.32	333	0.46
119		4,812	4	3	3.00	2.08	2.31	332	0.46
120		4,835	4	3	3.00	2.07	2.30	331	0.46
121		4,857	4	3	3.00	2.06	2.29	330	0.46
122		4,880	4	3	3.00	2.05	2.29	329	0.46
123		4,902	4	3	3.00	2.04	2.28	328	0.46
124		4,924	4	3	3.00	2.03	2.27	327	0.45
125		4,947	4	3	3.00	2.02	2.27	326	0.45
126		4,969	4	3	3.00	2.01	2.26	325	0.45
127		4,992	3	2	2.00	2.00	2.00	288	0.40
128		5,014	3	2	2.00	1.99	2.00	287	0.40
129		5,037	3	2	2.00	1.99	1.99	286	0.40
130		5,132	3	2	2.00	1.95	1.96	282	0.39
131		5,154	3	2	2.00	1.94	1.96	282	0.39
132		5,176	3	2	2.00	1.93	1.95	281	0.39
133		5,199	3	2	2.00	1.92	1.94	280	0.39
134		5,221	3	2	2.00	1.92	1.94	279	0.39
135		5,244	3	2	2.00	1.91	1.93	278	0.39
136		5,266	3	2	2.00	1.90	1.92	277	0.38
137		5,289	3	2	2.00	1.89	1.92	276	0.38
138		5,311	3	2	2.00	1.88	1.91	275	0.38
139		5,333	3	2	2.00	1.87	1.91	274	0.38
140	Height 2/3	5,429	3	2	2.00	1.84	1.88	271	0.38
141		5,451	3	2	2.00	1.83	1.88	270	0.38
142		5,473	3	2	2.00	1.83	1.87	269	0.37
143		5,496	3	2	2.00	1.82	1.86	269	0.37
144		5,518	3	2	2.00	1.81	1.86	268	0.37
145		5,541	3	2	2.00	1.80	1.85	267	0.37
146		5,563	3	2	2.00	1.80	1.85	266	0.37
147		5,585	3	2	2.00	1.79	1.84	265	0.37
148		5,608	3	2	2.00	1.78	1.84	265	0.37
149		5,703	3	2	2.00	1.75	1.82	261	0.36
150	3rd round	5,725	3	2	2.00	1.75	1.81	261	0.36
151		5,748	3	2	2.00	1.74	1.80	260	0.36
152		5,770	3	2	2.00	1.73	1.80	259	0.36
153		5,793	3	2	2.00	1.73	1.79	258	0.36
154		5,815	3	2	2.00	1.72	1.79	258	0.36
155		5,837	3	2	2.00	1.71	1.78	257	0.36
156		5,860	3	2	2.00	1.71	1.78	256	0.36
157		5,955	3	2	2.00	1.68	1.76	253	0.35
158		5,977	2.9	1.9	1.90	1.67	1.73	249	0.35
159		6,000	2.8	1.8	1.90	1.67	1.73	248	0.35
160		6,022	2.7	1.9	1.90	1.66	1.72	248	0.34

Table 3 – Transport Lanes /6

Level No.	Property	Workers total one lane	Total lanes	Delivery lanes	Maximal transport lanes	Mininmal transport lanes	Average transport lanes	Average blocks /day	Average blocks /minute
161		6,045	2,6	1,9	1,90	1,65	1,72	247	0,34
162		6,067	2,6	1,8	1,80	1,65	1,69	243	0,34
163		6,089	2,5	1,8	1,80	1,64	1,68	242	0,34
164	Vol. 99%	6,185	2,5	1,7	1,70	1,62	1,64	236	0,33
165		6,207	2,4	1,7	1,70	1,61	1,63	235	0,33
166		6,229	2,4	1,6	1,60	1,60	1,60	230	0,32
167		6,252	2,3	1,5	1,50	1,50	1,50	216	0,30
168		6,274	2,3	1,5	1,50	1,50	1,50	216	0,30
169		6,369	2,2	1,4	1,40	1,40	1,40	202	0,28
170		6,392	2,2	1,3	1,30	1,30	1,30	187	0,26
171		6,414	2,1	1,2	1,20	1,20	1,20	173	0,24
172		6,437	2,1	1,2	1,20	1,20	1,20	173	0,24
173		6,459	2,0	1,1	1,10	1,10	1,10	158	0,22
174		6,554	1,9	1	1	1	1	144	0,20
175	4th round	6,577	1,8	1	1	1	1	144	0,20
176		6,599	1,7	1	1	1	1	144	0,20
177		6,621	1,6	1	1	1	1	144	0,20
178		6,717	1,5	1	1	1	1	144	0,20
179		6,739	1,4	1	1	1	1	144	0,20
180		6,761	1,3	1	1	1	1	144	0,20
181		6,784	1,2	1	1	1	1	144	0,20
182		6,879	1,1	1	1	1	1	144	0,20
183		6,901	1	1	1	1	1	144	0,20
184		6,924	1	1	1	1	1	144	0,20
185		6,946	1	1	1	1	1	144	0,20
186		6,969	1	1	1	1	1	144	0,20
187		6,991	1	1	1	1	1	144	0,20
188	Vol. 99.9%	7,013	1	1	1	1	1	144	0,20
189	5th round	7,036	1	1	1	1	1	144	0,20
190		7,058	1	1	1	1	1	144	0,20
191		7,081	1	1	1	1	1	144	0,20
192		7,103	1	1	1	1	1	144	0,20
193		7,125	1	1	1	1	1	144	0,20
194		7,148	1	1	1	1	1	144	0,20
195		7,170	1	1	1	1	1	144	0,20
196		7,193	1	1	1	1	1	144	0,20
197		7,215	1	1	1	1	1	144	0,20
198		7,237	1	1	1	1	1	144	0,20
199	6th round	7,260	1	1	1	1	1	144	0,20
200	Vol. 99,99%	7,282	1	1	1	1	1	144	0,20
201		7,305	1	1	1	1	1	144	0,20
202		7,327	1	1	1	1	1	144	0,20
203	7th round	7,350	1	1	1	1	1	144	0,20
204		7,372	1	1	1	1	1	144	0,20
205		7,394	1	1	1	1	1	144	0,20
206		7,417	1	1	1	1	1	144	0,20
207	8th round	7,439	1	1	1	1	1	144	0,20
208		7,462	1	1	1	1	1	144	0,20
209	9th round		1						
210	Pyramidion								

Analysis



The **stepped purple curve** represents the number of **total lanes** that physically reach the corresponding level.

The values are constructed geometrically from the 4 plans of the pyramid's faces. These are listed in **Table 1** and are adopted here.

There were 13 lanes at ground level.

The **yellow curve** represents the possible delivery routes. This is derived from the purple curve by subtracting one lane for the return route.

Until the construction of level 55, the wide ramp could be built to any desired width and therefore, the purple line could be any size. This is indicated by the dashed vertical line and corresponds to the bottom quarter of the pyramid. At this stage of construction, there were even 2 return lanes possible. Separate return lanes were needed to allow for circular movement.

The **brown** (maximal) curve represents the number of transport lanes during the 3 months of the Nile flood.

All 20,000 workers could be deployed up to level 55. Therefore, this phase of the construction process was limited only by the workers, i.e., **capacity-limited**.

But then, the ramp paths became fewer as the space around the pyramid became increasingly narrow with increasing height. Therefore, fewer workers could be employed with increasing height.

The brown line cannot be greater than the yellow line.

From level 56 onwards, there was only enough space for a total of 7 lanes or 6 delivery lanes. Therefore, only $3,110 \cdot 6 = 18,660$ workers could be employed during the Nile flood.

In this phase, the construction process was limited only by the number of lanes. Therefore, the brown curve is bounded by the yellow curve, and the process was **space-limited**.

The **green curve** (minimal) represents the number of transport lanes during the 9 months outside the Nile flood.

All 10,000 workers could be deployed up to level 166.

Therefore, it is understandable that the green and brown curves converge and are identical from level 166 onwards.

The **blue curve** (average) represents the annual average of the green and brown curves. There were 7 transport lanes at ground level and only 1 lane near the pyramidion.

This is the decisive result of the project and a measure of the overall system's performance. Multiplying this number by 144 immediately yields the second key figure, the average number of blocks installed per day.

Up to level 157, the wide path had a width of 3 lanes, or 9.9 m.

As the altitude increased, this path became increasingly narrower. Therefore, the purple curve decreases not by steps but linearly in this segment.

From level 174 onwards, the path had a width of only 1 lane, or 3.3 m.

Final Remark:

This table combines the results in **Table 1** (physically existing lanes) and **Table 2** (workers one lane) to determine the number of transport lanes per level.

Table 4 determines the construction time of each level.

The construction time of the entire pyramid can be calculated by summing the construction times of the individual levels.

In each table the derived results are solely a consequence of the results in the preceding tables. There are no hidden assumptions, no implicit leaps.

All tables, images, and further information www.cheops-pyramid.net/en

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