

THE WEIGHT OF THE ARK OF THE COVENANT

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The Tabernacle in the time of Moses, as described in Exodus 25:10-22, was built to be a portable temple which could be transported from place to place in the desert. Therefore, the weights of its components could not be excessive. Most commentaries have ignored this point and have disregarded weight calculations. For example, Rashi on Exodus 26:17 assumes that the planks, that were 10 cubits high and 1.5 cubits wide, were 1 cubit (at least 43 centimeters) thick. The weight of such planks would be at least 1320 pounds (600 kilograms), which would have made it impossible to transport 48 such planks (plus other planks and silver sockets) through the desert in four wagons pulled by only two oxen each (Num. 4:29-32; 7:8). An alternative estimate that the planks were only about one centimeter thick is therefore more likely correct.

In the light of the fact that most commentaries do not calculate the weight of the Tabernacle, I was pleased to see the article by Josiah Derby¹ wherein he attempts to calculate the weight of the Ark of the Covenant, including the weight of the gold overlay. He calculates that weight at about 288 pounds (131 kilograms), and argues that is too heavy for four men to carry on their shoulders, each having to bear a load of about 72 pounds (33 kilograms). This conclusion disturbed me, because the Ark was carried many times on the shoulders of four men (see in particular Ex. 25:14; Num. 7:9; Jos. 3:13; 4:16; 6:12; I Kgs. 2:26; I Chr. 15:15).

I am, therefore, presenting a modified calculation of the weight of the Ark, based on the calculations in my commentary on the Book of Exodus². This calculation will be performed in the scientific centimeter-gram system of units as well as the foot-pound units used by Derby. The weight for the Ark comes out to only 183 pounds (83 kilograms), which four men could carry on

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their shoulders without difficulty, each bearing a load of about 46 pounds (21 kilograms).

The calculations made by Derby need the following corrections:

1. The density of the gold is given as 1197 pounds/cubic foot (19.2 grams/cubic centimeter). This value is correct for pure gold. However, the gold used in ancient times must have contained a percentage of impurities, and its density would be closer to 1061 pounds/cubic foot (17.0 grams/cubic centimeter).

2. The thickness of the gold overlay is assumed to be 1/64 inch (0.04 centimeters). However, my calculations show that the thickness should be approximately 0.02 centimeters. In Exodus 38:24, the total weight of the gold for all the vessels used is given as 29 talents and 730 shekels. The weight of a talent is equivalent to 3000 shekels. Therefore, the total weight was $29 \times 3000 + 730 = 87,730$ shekels. Based on the data in the *Encyclopedia Biblica*³ a shekel weighs 11.4 grams. Hence the total weight of gold was 2200.2 pounds (1000.1 kilograms). I calculated the total weight of the gold for all the vessels, and had to use a thickness for the gold overlay of 0.02 centimeters in order to approximate this value. In actuality, I obtained a total weight of 2420 pounds (1100 kilograms), which I felt was close enough to the value stated in the text considering all the assumptions and approximations that were involved in the calculations.

3. The cubit was assumed to be 18 inches (45.7 centimeters). This is a fairly reasonable value. However, the figures in the Siloam Inscription (eighth century BCE) yield a slightly smaller value for the cubit. The inscription states that the Siloam tunnel is 1200 cubits in length. The tunnel is still extant, and the shortest measurement gives a length of 520 meters,⁴ from which is obtained a value for the cubit of about 17 inches (43.2 centimeters).

4. The weight of the two Tablets of the Covenant is figured at 60 pounds (27.3 kilograms). However, Moses came down from Mount Sinai carrying both of them in one hand (Ex. 32:15, 34:4). It would be extremely difficult to do this if they weighed 60 pounds. A more reasonable value would be 11 pounds (5 kilograms) for the two together. This would be the case if we assume that the tablets were each 25 centimeters long by 20 centimeters wide by 2 centimeters thick, and the density of the stone was 156 pounds/cubic foot (2.5 gram/cubic centimeter). The Ten Commandments were written on

both sides of both of the flat stone tablets, perhaps with verses of Exodus 20 divided as 2-4, 5-7, 8-11, and 12-14.

5. The dimensions of the Ark were 2.5 cubits long by 1.5 cubits wide by 1.5 cubits high (Ex. 25:10). Counting the cubit as equal to 43.2 centimeters, the dimensions are 108.0 centimeters by 64.8 centimeters by 64.8 centimeters. If the wood was 1.0 centimeter thick, and the density of the wood was 0.5 gram/cubic centimeter, the weight of the wood was (32.3 pounds) 14.7 kilograms ($2 \times 64.8 \times 64.8 \times 1.0 \times 0.5 + 3 \times 108.0 \times 64.8 \times 1.0 \times 0.5$). Derby assumed that the weight of the wood was 50 pounds (22.7 kilograms).

6. The *kapporet* (cover of the Ark) consisted of two connected parts; the flat part that covers the Ark and the two cherubim that spread their wings over it (Ex. 25:17-21). Derby assumes that the flat part must be at least 1/16 inch thick (0.16 centimeter) so as not to buckle. However, the gold used is not pure gold, and a thinner layer of gold (such as 0.10 centimeter) would have sufficient structural strength. The weight of the flat part is then $108.0 \times 64.8 \times 0.10 \times 17.0 = 11.9$ kilograms (26.2 pounds). However, Derby gets a value of 52.73 pounds (24.0 kilograms), using a thickness of 0.16 centimeters for the flat part, 45.7 centimeters for the value of the cubit, and a density of 19.2 grams/cubic centimeter for the gold.

The weight of the cherubim cannot be calculated exactly because we do not know their exact size. Derby makes several assumptions, and calculates their weight to be 39.52 pounds (18.0 kilograms). My assumed weight for the cherubim is somewhat higher; namely, 55.0 pounds (25.0 kilograms).

In total, he obtains 92.25 pounds (42.0 kilograms) for the weight of the *kapporet*. In contrast, I obtain 81.2 pounds (36.9 kilograms).

7. The gold overlay was applied to both the inside and outside of the Ark. The surface area of the wood is $2 \times 2 \times 64.8 \times 64.8 + 2 \times 3 \times 108.0 \times 64.8 = 58786.56$ square centimeters. By multiplying this area by 0.02 for the thickness of the overlay and by 17.0 for the assumed density of the gold we obtain 20.0 kilograms (44.0 pounds) as weight of the gold overlay. In contrast, Derby obtained a weight of 82.86 pounds (37.7 kilograms) for the gold overlay.

8. The diameter of the carrying poles (Ex. 25:13-15) was assumed to be approximately 2 inches (5.1 centimeters). Thereby, Derby obtained a weight of about 3 pounds (1.4 kilograms) for the poles, their gold overlay and the gold rings. My own calculations for the poles are more detailed. I assume that

they were placed on the shorter sides of the Ark, and that they were 4 centimeters in diameter and 124.8 centimeters in length. This is equivalent to the width of the Ark plus 60 centimeters necessary for the men to hold the poles on their shoulders. The volume of the poles is then 2×1568 cubic centimeters, and their weight is 1.57 kilograms. The surface area of the poles is 2×1568.3 square centimeters and the weight of the gold overlay is $0.02 \times 17 \times 3136.6 = 1.07$ kilograms. Hence, the total weight of the gold-coated poles is $1.57 + 1.07 = 2.6$ kilograms (5.7 pounds). The weight of the four gold rings that hold the carrying poles is almost negligible. I assumed that their thickness was 0.2 centimeters, their inside diameter 4.0 centimeters, and that they were complete circles. Their resultant weight is then 0.03 kilograms.

9. Derby's calculations did not include the weight of the decorative gold molding (crown) all around the top of the Ark (Ex. 25 11). My estimate is that the molding was one handbreadth (one-sixth of a cubit = 7.2 centimeters) wide and 0.1 centimeter thick. This thickness provides sufficient structural strength for the molding. Its weight is then $7.2 \times 2 \times (108 + 64.8) \times 17 \times 0.1 = 4.2$ kilograms (9.2 pounds).

The total weight obtained for the Ark, as stated above, is 83 kilograms (183 pounds), which consists of $5.0+14.7+11.9+25.0+20.0+2.6+0.03+4.2$ kilograms. Each of the four men carrying the Ark would bear a weight of about 21 kilograms (46 pounds), which can easily be tolerated on the shoulders for extensive periods of time. If necessary, the carriers could use shoulder padding to ease the pressure of the poles on the shoulders.

NOTES

1. Josiah Derby, "The Gold of the Ark," *Jewish Bible Quarterly*, Vol. 33:4 (Oct. 2005) pp. 253-256.
2. E.A. Schatz, *Commentary by Elihu on the Book of Exodus* (Hashmonaim, by the author, 2001) pp. 136-137 (in Hebrew).
3. *Encyclopaedia Biblica* (Jerusalem: Bialik Institute, 1962) Vol. 4, p. 867 (in Hebrew).
4. D.W. Thomas, *Documents From Old Testament Times* (New York: Harper Torchbook ed., 1961) p. 209.