

BUOYANCY AND STABILITY OF NOAH'S ARK

I. INTRODUCTION

According to the Genesis chronology, 1656 years after the creation God sent a global Flood on the earth intended to wipe out the evil of antediluvian man. Genesis 6:3 implies that 120 years before the Flood was to come, God gave Noah instructions for saving all who would escape the Flood. As events unfolded, only Noah, his wife, and his sons and their wives entered the Ark (Gen. 6:18, 7:7).

The pre-Flood earth of about 3000 BC most likely had a substantial population, possibly much larger than today's supposedly excess population,¹ but only eight righteous ones survived the Flood (1 Pet. 3:18-20). The Bible does not say whether Noah had children before the Flood other than Shem, Ham, and Japheth (Gen. 5:32) who refused God's offer of safety in the Ark, nor are we told that the Ark actually required 120 years to build.

On the other hand, Genesis 6:15 presents the Ark's dimensions, and clearly the Ark was quite large. Shaped like a long rectangular box, it was not especially streamlined but was designed to outlast the year-long Flood storm, providing safe haven for the inhabitants. **It was 300 cubits long, 50 cubits wide, and 30 cubits high.** Taking the cubit as 18 inches, a fairly conservative value, the Ark was 450 ft x 75 ft x 45 ft.

There is no reason to assume that sailing vessels were not in use before the Flood. Indeed, there is some evidence that wooden vessels comparable to the Ark's size were built early on after the Flood.² Later - sometime after the dispersion from Babel - shipbuilding and much else in the ancient world regressed, and a ship roughly the dimensions of the Ark was not built again until the mid-1800s when the *Great Eastern* was used to lay the first trans-Atlantic telegraph cable.³

At nine feet per storey, the Ark was as tall as a five floor building, and as long as one and a half football fields. With the dimensions stated above, **its volume was about 1.5 million cubic feet, the capacity of over 500 railroad cattle cars** (Morris, 1984, p. 291). The fossil record formed and preserved in the Flood testifies to a huge antediluvian animal population, consistent with the possibility of immense human population then.⁴ However, all these creatures except those on the Ark would die in the Flood waters (Gen. 7:18-24).

The Ark's ample size guaranteed sufficient room for the animals God had directed to it (Gen. 6:19-20, 7:2-3, 14-15).⁵ However, **not species - a manmade designation - but kinds, genetically more inclusive than single species, entered the Ark.** Thus the sum total of *kinds* on the Ark was much less than modern species counts, and was readily manageable. Water-dwelling animals did not enter the Ark, only air-breathers (Genesis 7:14-15).

Nevertheless, in God's providence the Ark contained all the air-breathing animals and people that would repopulate the earth

after the Flood. **It was therefore essential that the Ark be stable and virtually impossible to capsize** in even the most severe conditions of the Flood.

As we will now see, the required stability was guaranteed by the very dimensions of the Ark which God had revealed to Noah.

II. BUOYANCY, WEIGHT & CAPACITY OF THE ARK

Genesis 7:19-20 indicates that the Flood waters submerged the highest hills to a depth of 15 cubits (22½ ft). The *draft* of a vessel is the depth of the vessel submerged under water. Taking the 15 cubit figure as the maximum draft of the Ark fully loaded, we can estimate its maximum weight. The actual weight may have been less, corresponding to a smaller draft.

By Archimedes' Principle, the weight of a floating object is the weight of the fluid it displaces. The bottom of the Ark had an area equal to its length times its width, or

$$450 \text{ ft} \times 75 \text{ ft} = 33,750 \text{ ft}^2$$

The maximum volume of water displaced would have been this area multiplied by the draft of 22½ ft:

$$33,750 \text{ ft} \times 22.5 \text{ ft} = 759,375 \text{ ft}^3$$

The density of fresh water is 62.4 lb/ft³, and the density of ocean water is close to this value. This would make the maximum weight of water displaced equal to

$$759,375 \text{ ft}^3 \times 62.4 \text{ lb/ft}^3 = 47,385,000 \text{ lb}$$

Thus the maximum weight of the fully loaded Ark was about

47million lb or about 24 thousand tons

Let us assume that the weight of the Ark itself and provender for the passengers made up 90% of this figure, and that only 10% of this weight consisted of people and animals. Thus we have the weight of live cargo as

$$4.7 \text{ million lb or } 2400 \text{ tons.}$$

The average animal weighs less than 100 lb. In fact, biologists class creatures weighing over 100 lb as *megafauna*, Greek for "large beasts." (Yes, people are considered megafauna!) Let us conservatively suppose, however, that the average animal on the Ark weighed 100 lb. Thus we have a carrying capacity for the Ark of

$$4,700,000 \text{ lb}/100 \text{ lb per animal} = 47,000 \text{ animals}$$

Woodmorappe (1996, pp. 11, 72) after an exhaustive survey concluded that the Ark carried 15,754 animals, or about 16,000. This is about one-third of the carrying capacity

estimated above from buoyancy considerations. Clearly, **the Ark was not filled to capacity. Room remained for freedom of movement and living space during the Flood year.**

III. STABILITY OF THE ARK

The Effect of Wave Torque on the Ark. The Ark's length was six times its width. This great length ensured that the Ark would run with the waves rather than opposing them, which could result in the Ark's being weakened or destroyed.

Suppose the Ark were initially positioned nearly perpendicular to the direction of oncoming waves. Long, "uniform crest-trough sequences" are rare on the open ocean, with most waves occurring in "broken and varying patterns" (Morris, 1984, p. 295). Existing broken waves would exert a twisting action or torque on the Ark.

The lever-arm in such a torque could be up to half the length, or 150 cubits (225 ft). Such an extensive lever-arm would magnify minimal wave forces to rotate the long axis into a direction parallel with the direction of waves and currents.

Once established, this orientation would be maintained by successive wave forces. Thus the Ark would continually run with the waves.

The Effect of Torque in Righting the Ark. Since the Ark ran with the waves, capsizing would have been unlikely apart from any other considerations. However, the Ark had a cross section of 50 cubits breadth by 30 cubits height. This rectangular cross section combined with the 15 cubit draft, and the fact that the Ark had a closed top (except for a narrow one cubit window all around, Gen. 6:16), made it virtually impossible to capsize even in the strongest waves.

When floating on a calm surface, the shape of the displaced water volume would be rectangular, with a cross section of 50 cubits breadth by 15 cubits height (the maximum draft). The buoyant force vector would be collinear (act along the same line) as the gravitational force vector.

Now suppose the Ark listed, that is, it tipped through an angle. The weight of water displaced would not change, but the *cross section* of the displaced water volume would now be triangular instead of rectangular. The buoyant force and the gravitational force would still have the same magnitude, but the two vectors would no longer be collinear. The buoyant force vector would act at the centroid (center) of the triangle, but the gravitational force would continue to act at the center of gravity.

With the two vectors on different lines of action, **they would form a force couple capable of exerting a twisting action or torque which could right the Ark.**

The affect of hyper-wave action on a scale model of the Ark was simulated in a wave tank at the Scripps Institute of Oceanography at La Jolla, California. A wave-generating machine battered the model with waves proportionately larger

than any storm could produce. These tests demonstrated that the Ark indeed could not be capsized (Morris, 1984, p. 295).

IV. CONCLUSIONS

God supernaturally watched over the Ark and its inhabitants (Gen. 8:1), but He also designed the physical characteristics of the Ark to harness natural forces so as to provide protection.

Notes

1. Genesis 6:11 states that before the Flood "the earth was filled with violence," implying that the earth was also "filled" with people and so had a large human population. Even today the estimated "carrying capacity" of the earth is as high as 48 million, supposing an intake up to 4500 calories per day per person and no change in politico-economic structure (Revelle, 1974, p. 168; Easterbrook, 1999, p. 28). Global pre-Flood population may have been several times larger.

2. Woodmorappe (1996, p. 50) notes that, "[T]here is evidence that ships approaching Ark length have in fact existed in ancient times." The legendary ancient Greek ship variously known as *Syracusia* or *Alexandris* is supposed to have rivaled the Ark's size (Casson, 1971, p. 185).

3. The *Great Eastern* "was the largest ship afloat when launched" in 1859, and was 692 ft long. It had an iron hull (Owen, 1970, p. 439). Some Chinese junks of centuries ago may have matched the *Great Eastern* in size (Mills, 1960, p. 147).

4. The fossil record, deposited almost entirely in the Flood, has uncounted billions if not trillions of specimens. Further, antediluvian vegetation was much more abundant than plant biomass in the world today. This is indicated by the huge amount of biomass required to form the coal reserves deposited in the Flood. The present world is biologically impoverished compared to the pre-Flood world.

5. Noah did not gather the animals himself, but was to accept the particular ones that God brought to him. On the other hand, gathering food for the animals was Noah's responsibility (Gen. 6:21).

References

- Casson, L. 1971. *Ships and Seamanship in the Ancient World*. Princeton University.
- Easterbrook, G. 1999. Reproductivity: Overpopulation Is No Problem – In the Long Run. *New Republic*. 221(15):22-28.
- Mills, J.R. 1960. The Largest Chinese Junk and Its Displacement. *Mariner's Mirror*. 46:147-148.
- Morris, H.M. 1984. *The Biblical Basis for Modern Science*. Baker, Grand Rapids, Mich.
- Owen, W. 1970. Ship and Shipbuilding. *The Collegiate Encyclopedia*. Grolier International, New York. 16:436-441.
- Revelle, R. 1974. Food and Population. *Scientific American*. 231(9):161-170.
- Woodmorappe, J. 1996. *Noah's Ark: A Feasibility Study*. Institute for Creation Research, El Cajon, Calif.