THE ARK OF NOAH

HENRY M. MORRIS*

Physical features of the ark described in Genesis 6 are considered in this paper. Such factors as buoyancy, water displacement, weight, and metacentric height are expanded with appropriate calculations. It is concluded that this craft was eminently suitable for preserving man and animal during the year of the great Flood.

Purpose of the Ark

The Biblical record of the great Flood is quite explicit in describing it as a world-wide cataclysm. Its purpose and effect were, in God's own words, to:

> destroy man whom I have created from the face of the earth; both man, and beast, and the creeping thing, and the fowls of the air. (Genesis 6:7)

The destruction was universal, so far as land animals were concerned. "All in whose nostrils was the breath of life, of all that was in the dry land, died." (Genesis 7:22)

However, in order to preserve two of each kind of animal, with which to re-populate the earth after the Flood, as well as Noah and his family, God gave directions for the building of the Ark.

> "Make thee an Ark of gopher wood," He said, "rooms shalt thou make in the Ark, and shalt pitch it within and without with pitch. And this is the fashion which thou shalt make it of: The length of the Ark shall be three hundred cubits, the breadth of it fifty cubits, and the height of it thirty cubits. A window shalt thou make to the Ark, and in a cubit shalt thou finish it above; and the door of the Ark shalt thou set in the side thereof; with lower, second and third stories shalt thou make it." (Genesis 6:14-16)

Size of the Ark

The Ark was thus to be essentially a huge box (the Hebrew word itself implies this), designed essentially for stability in the waters of the Flood rather than for movement through the waters. Assuming the cubit to be 1.5 ft., which is the most likely value, the dimensions of the Ark were 45 ft. x 75 ft. x 450 ft., as sketched in Figure 1, to a scale of 1" = 100'.

The Ark was obviously a very large structure, taller than a normal three-story building and half again as long as a football field. The total volumetric capacity was 450 x 45 x 75 = 1,518,750 cubic feet, or 56,361 cubic yards. Since the standard railroad stock car contains 2,670 cubic feet effective capacity, the Ark had a volumetric capacity equal to that of 569 standard stock cars.

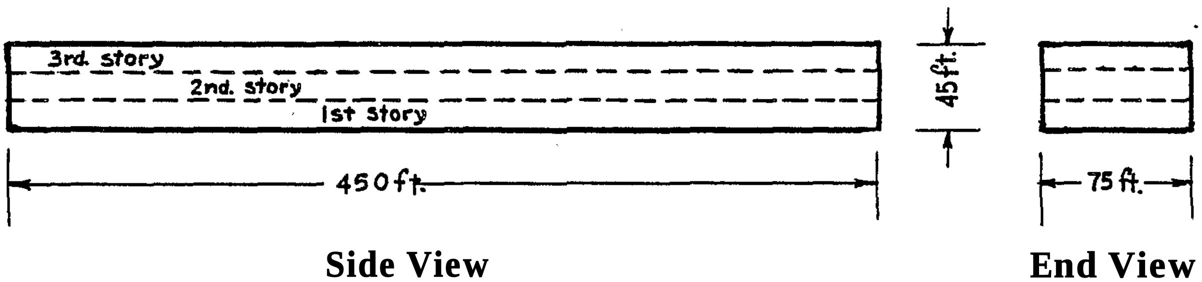

Figure 1. Dimensions of Noah's Ark.

It obviously could have carried a tremendous number of animals, and was clearly designed to hold representatives from all kinds of animals throughout the entire world.

Stability of the Ark

In the complex of hydrodynamic and aerodynamic forces unleashed in the Flood, it was necessary that the Ark remain afloat for a whole year. The gopher wood of which it was constructed was no doubt extremely strong and durable.

Timbers forming the sides and bottom, as well as the floors of the intermediate decks, were probably cut and shaped from great trees that had been growing since the world began, over 1600 years earlier. The "pitch" (Hebrew *kaphar,* meaning simply "covering") was evidently an excellent waterproofing material, though we do not now know what it was.

In addition to floating it must not capsize under the impact of the great waves and winds which might beat against it. The Scripture says the floodwaters rose at least 15 cubits above the highest mountains (Genesis 7:20), evidently to

*Henry, M. Morris, Ph.D., is director of The Creation Science Research Center, and academic vice-president of Christian Heritage College, 2716 Madison Avenue, San Diego, California 92116.

point out that the Ark was floating freely wherever the waters might propel it. The height of the Ark was 30 cubits, so it seems probable that the 15 cubit figure represents the draft of the Ark when loaded.

When the Ark was floating at this depth, Archimedes' principle tells us that its weight must have equalled the force of buoyancy, which in turn equals the weight of the equivalent amount of water displaced. The weight of the Ark therefore was

$$W = 450(75)\left(\frac{45}{2}\right)(w)$$

where w is the weight of each cubic foot of water.

Fresh water weighs 62.4 lbs. and sea water 64 lbs. per cubic foot. Because of the minerals and sediments in the water, its density may well have been at least that of sea water, in which case the weight of the Ark would be calculated at 48,600,000 pounds; this is close enough for practical purposes.

The average unit weight of the Ark must then be half that of the water, or 32 lbs. per cubic foot. The center of gravity of the ark and its contents presumably would be close to its geometric center, with the framework, the animals, and other contents more or less uniformly and symmetrically dispersed throughout the structure.

Two Tests of Stability

The Ark as designed would have been an exceptionally stable structure. Its cross-section of 30 cubits height by 50 cubits breadth, with a draft of 15 cubits, made it almost impossible to capsize, even in the midst of heavy waves and violent winds.

To illustrate this, assume the Ark tipped through an angle such that the roof was actually touching the water's edge, as sketched in Figure 2. This is an angle of approximately 31°, that is the angle whose tangent is 30/50. Since the weight of the Ark continues unchanged, it must still displace an amount of water equal to half its cross-section. Thus the water surface coincides with the diagonal. The buoyant force B continues to equal W, the weight of the Ark.

However, the two forces are not now acting in the same line. The weight W acts vertically downward through the center of the Ark's cross-section. The force B acts vertically upward through the centroid of the triangle LQN, since this is the location of the center of gravity of the volume of water that has been displaced by the Ark. The two forces W and B, equal in magnitude but opposite in direction, form a *couple*, of intensity equal to the product of either force times the distance between them.

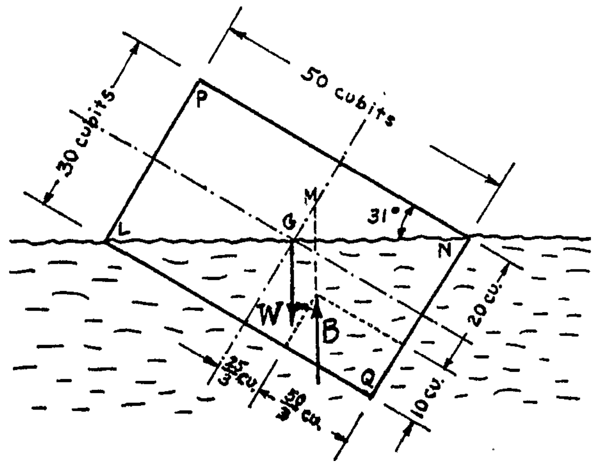

Figure 2. Stability of Ark at 31° angle of tilt.

As long as the line of action of B is outside that of W, in the direction toward the submerged side of the Ark, the couple is a "righting couple" and would act to restore the vessel to its upright position. The magnitude of the couple is of no particular interest, but the location of M, the *metacenter*, is significant. As long as M is above G (the centroid of the entire vessel cross-section) on the axis of symmetry of the vessel, then the ship is stable.

For the condition shown, M can be calculated to be 8.9 cubits above G on the axis of symmetry (calculated. from dimensions shown on the sketch, as $\frac{25/3}{\tan 31°} - 5 = \frac{125}{9} - 5 = \frac{80}{9}$ cu.). This is almost 13.5 ft. above the centroid and indicates the Ark was extremely stable, even under such a strong angle of listing. The righting couple is then equal to 8.9 (sin 31°) (W) = $\left[\frac{80}{(3\sqrt{34})}\right]$ (48,600,000) = 222,000,000 ft.-lbs.

As a matter of fact, the *metacentric height*, as the distance GM is known, is positive for this cross-section even for much higher angles. Suppose the boat, for example, were tilted through a 60° angle, as shown in Figure 3. The centroid of the immersed area is obviously to the right of the line of action of G, and thus there is a righting couple and the metacentric height GM is positive.

As a matter of fact, the Ark would have to be turned completely vertical before M would coincide with G. Thus, for any angle up to 90°, the Ark would right itself.

Furthermore its relatively great length (six times its width) would tend to keep it from being subjected to wave forces of equal magnitude through its whole length, since wave fields tend to occur in broken and varying patterns, rather

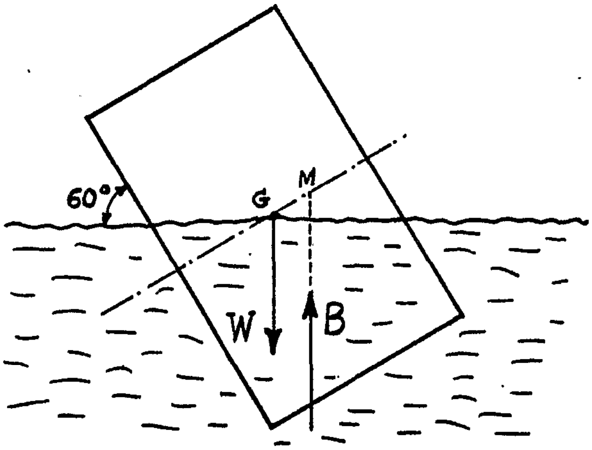

Figure 3. Stability of Ark at 60° angle of tilt.

than in a series of long uniform crest-trough sequences, and this would be particularly true in the chaotic hydrodynamic phenomena of the Flood. Any vortex action to which it might occasionally be subjected would also tend to be resisted and broken up by its large length-width ratio.

The Ark would, in fact, tend to be lined up by the spectrum of hydrodynamic forces and currents in such a direction that its long axis would be parallel to the predominant direction of wave and current movement. Thus it would act as a semi-streamlined body, and the net drag forces would usually be minimal.

In every way, therefore, the Ark as designed was highly stable, admirably suited for its purpose of riding out the storms of the year of the great Flood.

ARTICLE REVIEW

"Carlsbad Caverns in Color," by Mason Sutherland (in) *National Geographic Magazine,* CIV: 4:433-468. October, 1953.

Reviewed by Robert Harris.*

> . . . The Rock of Ages is the most celebrated formation in the caverns.
>
> Because of its huge bulk this stalagmite was popularly supposed to be one of the oldest decorations. Actually there is no good way of determining its exact age; no one can tell when it grew or how fast (p. 463).

Little seems to be known about the growth rates of dripstone; most authorities are content to indicate vaguely that the process is a slow one. Attempts to determine deposition rates through uniformitarian methods (the present is the key to the past) have been unsuccessful.

Comparing the growth of stalactites under concrete bridges with the Carlsbad formations has failed because of the highly variable conditions of deposition. Mineral concentration, speed and volume of water flow, and atmospheric conditions must be taken into account. Encyclopedia Britannica states:

> Conditions which favour dripstone deposition of calcium carbonates are (1) a source rock above the cavity; (2) downward percolation of water supplied from rain; (3) tight but continuous passageways for this water which determine a very slow drip; (4) adequate air space in the void to allow either (a) evaporation or (b) escape of carbon dioxide from the water which thus loses some of its solvent ability.[1]

Applying uniformitarian suppositions to the cavern formations themselves is also unreliable because not only is 95 percent of the caverns dry and inactive at the present, but also the most active formation, Crystal Spring Dome, is not growing at a constant rate. (In spite of the present dry New Mexico desert above, one day's measurement put the rate at 2.5 cubic inches per year in 1953 [p. 455].)

Although the author muses about the possibility of a guano deposit being "perhaps a million years old" (p. 452), he does admit that even by uniformitarian dating, "Few of these . . . [dripstone] formations can exceed 100,000 years, for many rest on silt and fossils believed to be of that age," (p. 446).

The most interesting and revealing picture in the article, which may give a clue to growth rates, is on page 442, showing the clear outline of a bat cemented upside down in a stalagmite! Due to bacterial decay and scavenger attack, it seems unlikely that a bat's body would last several thousand years before entombment in calcium carbonate. Rather it would appear that very rapid growth would be required—perhaps even catastrophic growth.

Much study into cave phenomena is needed, The power of crystallization is strong enough to defy gravity, allowing helictites to grow in any direction; perhaps further research will disclose that possible growth rates are likewise amazing by virtue of rapidity.

*Robert Harris is a student at the University of California, Santa Barbara, California.

Reference

[1]Encyclopedia Britannica, 1970 Edition, Vol. 21, page 104.