Which cubit for Noah's Ark?

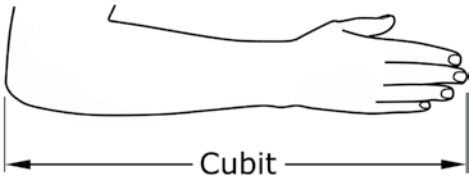
Tim Lovett

Noah's Ark is the earliest ship known to man. Amazingly, an accurate record of its dimensions has survived to this day, in Genesis 6:15. However, the Bible uses cubits, an ancient measure that may have been anywhere from 445 mm (17.5 in) to more than 609 mm (2 ft) long, depending on when and where it was used. The standard chronology places the Tower of Babel so soon after Noah's Ark that they must have shared the same cubit. After the dispersion this cubit should have found its way into early structures and monuments. Today, when we look in the ancient Near East for the best clues, we find that the earliest major works in Egypt and Babylon used long cubits. Could this be the one that Noah used?

The cubit

> 'The length of the Ark shall be three hundred cubits, the breadth of it fifty cubits, and the height of it thirty cubits' (Genesis 6:15).

How long is a cubit? The word comes from the Latin *cubitum*[1] which refers to the forearm. It was measured from the elbow to the fingertip. This provides a foolproof method of gauging the size of Noah's Ark—at least approximately.



While cubits vary greatly, in key civilizations like Egypt and Babylon there were two distinct size ranges, a shorter 'common' cubit around 450 mm and a longer 'royal' cubit of 520 mm or so (see Appendix 1).

Short of the famous vessel turning up on a mountaintop someday, establishing the exact cubit length used for Noah's Ark may appear to be an impossible mission. But a good place to start is simply this: which class of cubit is the more likely candidate, the 'royal' or the 'common'?

In the following discussion, the 'royal' cubit is a generalized definition of the longer cubits of the ancient Near East that range from 517 to 546 mm, at least 13% longer than the common cubit. The Royal Egyptian Cubit (REC) is more specifically 524 mm (figure 1).

A cautious choice

The 1961 bombshell *The Genesis Flood*[2] demolished many misconceptions about the biblical Flood. Suddenly Noah's Ark was a real vessel. Whitcomb and Morris chose a 'cautious' cubit of 18 in (457 mm), showing that even the smallest biblical Ark was enormous, nothing like the pictures in Sunday school books. Yet longer cubits were no secret. This same work quoted a study by Scott[3] describing cubits from 445 mm to 524mm.

Table 1 shows cubit lengths chosen by key creationist authors dealing with Noah's Ark, all clearly driven by a conservative space argument.

In every case the 'common' cubit has been chosen, despite clear evidence that it was the 'royal' cubit that dominated major building projects of the earliest civilizations, Noah's immediate descendents. The dominant primary source is the 1959 paper by R.B.Y. Scott[4], linking the cubit to things like the Siloam tunnel. However, Noah and the Siloam tunnel[5] are worlds apart.

Scott is happy to let late Hebrew architecture define Solomon's Temple and even Moses' Tabernacle. This is not surprising considering his view of Bible history, discrediting Moses as the author of Exodus in favour of the 'writers of the Priestly document'.[6] This documentary theory (JEDP) viewpoint would have the story of Noah's Ark fabricated at roughly the same time as the architecture that survives in Palestine, so a similar cubit is considered viable. In reality there is a gap of almost 2,000 years, and plenty of ancient cubits in between.

Perils of defensive cubit selection

> 'The cubit length of 17.5' to 18' was assumed in most studies because the focus had been on the Ark's volume. The authors took the conservative value of cubit size and then demonstrated that even the minimum space was adequate to fit all the animals on board. However, there are reasons to think longer alternatives, such as the royal cubits of Egypt and Babylon, may be preferable. I am certainly open to a longer cubit.'[7]

Skeptics claim Noah's Ark is too small to fit all the animals, yet too big to be made out of wood—an alleged dilemma.

By advocating the shortest cubit, creationist authors were making it clear that even the smallest Ark can fit all the animals. As it turns out, space is not really a problem. Woodmorappe loads the animals and cargo with room to spare, despite his assertion: 'I intentionally made the Ark-crowding problem so much more difficult than it actually was.'[8]

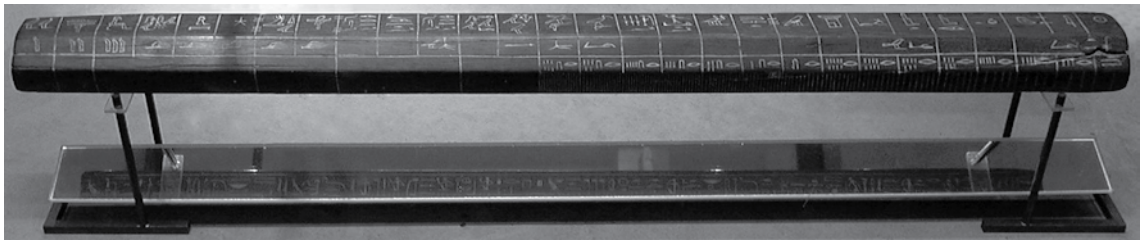


Figure 1. The most famous of cubits, the Royal Egyptian Cubit (REC) was divided into 7 palms of 4 digits each, totalling 28 digits altogether. (Photo by J. Bodsworth, <www.egyptarchive.co.uk/>).

Table 1. Cubit lengths assumed for Noah's Ark studies by key authors.

Year	Reference	Cubit	Author's Comment	Source
1961	Whitcomb, J.C. and Morris H.M., *The Genesis Flood*, Pres. and Reformed Pub. Co., NJ, 1961.	445 mm (17.5 in)	'While it is certainly possible that the cubit referred to in Genesis 6 was longer than 17.5 in, we shall take this shorter cubit as the basis for our calculations' (p. 10) .	Scott, R.B.Y., Weights and Measures of the Bible, *The Biblical Archaeologist* **22**:22–40, 1959.
1971	Morris, H.M., The Ark of Noah, *CRSQ* **8**(2):142–144, 1971.	457 mm (18 in)	'Assuming the cubit to be 1.5ft, which is the most likely value', (p. 142).	Approximation of R.B.Y. Scott for purpose of simplifying calculations? Morris uses 17.5 inches elsewhere.
1973	Whitcomb, J.C., *The World that Perished*, Baker, Grand Rapids, MI; 1973 (revised ed. 1988).	445 mm (17.5 in)	'Assuming the length of the cubit to have been at least 17.5 in, …' (p. 25).	After W and M 1961 (same author) so source is still R.B.Y. Scott.
1975	Giannone, R., A Comparison of the Ark with Modern Ships, *CRSQ* **12**(1):53, 1975.	457 mm (18 in)	'The cubit is understood to be 18 in, which seems to be at least approximately correct, …'	Probably Morris (*CRSQ* 1971).
1976	Morris, H.M., *The Genesis Record*, Baker Book House, Grand Rapids, MI, p. 181, 1976.	445 mm (17.5 in)	'To be very conservative, assume the cubit to have been only 17.5 in, the shortest of all cubits, so far as is known.'	Very similar wording to The Genesis Flood, by same author, so source is R.B.Y. Scott.
1977	Collins, D.H., Was Noah's Ark Stable? *CRSQ* **14**(2):83-87, Sept 1977.	457 mm (18 in)	'For present purposes I will assume the cubit equal to 18 in'; from cubit list in Ramm, 1956.[9]	Different source but same cubit as previous *CRSQ* authors.
1994	Hong, S.W. *et al*., Safety Investigation of Noah's Ark in a Seaway, *Journal of Creation* **8**(1):26–36, 1994.	450 mm (17.72 in)	'We adopted the common cubit … 17.5 in'; after Scott R.B.Y, 1959. Note: they used 450 mm.[10]	R.B.Y. Scott (metric approximation).
1996	Woodmorappe, J., *Noah's Ark: A Feasibility Study*, ICR, CA, p. 10, 1996.	457 mm (18 in)	'All the calculations in this work involving the Ark assume a short cubit of 45.72 cm.'	Wright, G.R.H., *Ancient Building in South Syria and Palestine*, Vol 1, E.'J. Brill, Leiden, p. 419, 1985.
2001	Gitt, W., *The Most Amazing Ship in the History of the World*, Fundamentum, Germany, p. 7, 2001 (German).	437.5 mm (17.22 in)	'0.4375 m', p. 8. (For comparison, Gitt provided eight other cubits including the enormous 66.69 cm Prussian cubit)	Modern Siloam Tunnel measurement (525 m) compared to inscription of 1,200 cubits which gives 525/1200 = 0.4375 m.

On the number of animals, no skeptic would bother to attack the Ark's volume on the creationist's own playing field, where the alleged millions of species have been trimmed down to Woodmorappe's 16,000[11] or the 35,000[12] estimate of Whitcomb and Morris. The opponents of the creationist Flood model argue for hundreds of times as many animals aboard the Ark, overruling a 13% discount on cubit length.

The short cubit also leaves the Ark's defense vulnerable to exactly the opposite charge—that creationists are understating the size to lessen the problem of an oversize wooden vessel coming apart in a big sea. Such a criticism warrants attention because larger hulls are more sensitive to wave loads,[13] increasing the risk of 'springing a leak'. Even the shortest version of Noah's Ark exceeds the length of any wooden ship for which there are indisputable records.[14]

What if we use a short cubit when dealing with the space issue, and a long cubit for the hull strength concerns? The problem with this approach is that ship design is not a simple dichotomy, but a balance of many factors. Considering only two basic parameters, cubit length and hull shape, table 2 shows how a different Ark is needed in each case to conservatively address only a few simple arguments.

The typical creationist ark (small cubit/block-like) is conservative in seakeeping, a relatively rare question. There are, of course, many more arguments and parameters to play with—ventilation, storm proofing, broaching resistance, construction and launch, various structural approaches, animal comfort, etc.

To always argue conservatively would require the short cubit in some cases and the long cubit in others. This is not very conclusive, unless there happens to be a particular cubit that makes the most sense historically and biblically.

Proposed origin of the royal cubits

The level of sophistication necessary for a 300-cubit-long seagoing vessel virtually assures that standardization was part of pre-Flood society.[16] Regardless of whose arm it was that defined Noah's cubit, immediately after the Flood it was the only one in existence.

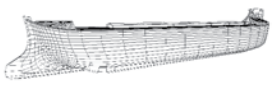
History has shown that standards of measure are rather persistent,[17] especially in a continuous culture. As Noah's family quickly expanded, the combination of longevity and 'one mindedness' (Genesis 11:6) would have kept this cubit intact right through to the Babel Tower.

The Babel dispersion should have sent Noah's cubit around the world, with varying levels of precision and persistence. The momentum of infrastructure would help preserve this standard in the nations that stayed close by, making early Mediterranean constructions the most likely place to find something resembling Noah's cubit. What we do find are royal cubits, such as the ancient but precise Royal Egyptian cubit of 524 mm,[18] used in the pyramids of Giza. There are other examples, like the 518 mm copper rod known as the Nippur cubit[19] found in Mesopotamia.

Biblical clues

Moses wrote (or compiled) Genesis some time before his death in 1451 BC (Ussher chronology). Obviously he would have been familiar with Egypt's common and royal cubits, but which one did he mean in Genesis? Perhaps here is a clue: when he wrote about the length of King Og's bed (Deuteronomy 3:11) he used the term 'the cubit of man', which sounds like a reference to something anatomically contemporaneous or a 'common' cubit. In that case the unqualified cubits in the rest of his writings (like Genesis) are likely to be the other ones—royal cubits. He

Table 2. Common objections and corresponding conservative interpretations of the Ark.

Common Objection	Worst Case	Which Hull form?	Comment
Capacity: Too small to fit animals	Smallest cubit, most streamlined, largest number of animals		This issue overshadowed by species/kinds debate
Stability: Capsize risk	Smallest cubit. Least stable – highest centre of mass, most rounded hull, worst waves and wind		Overly stable gives a rough ride.
Strength: Wood is too weak	Largest cubit, most block-like, weakest wood, worst waves		Ancient Greeks built structurally efficient hulls
Construction: Too difficult to make	Largest cubit, most complex hull shape, few workers, most primitive tools		Ancient people surprisingly capable, and had adequate technology
Seakeeping: Occupants thrown around	Smallest cubit, most block-like hull, worst waves and wind		The Ark established by Whitcomb/Morris

used unqualified cubits for the pattern of the Tabernacle (Exodus 25–27). The Hebrew craftsmen should have been well versed in the royal cubit from Egypt before they built the Tabernacle. Zuidhof [20] argues for the seven-palm royal as the most appropriate measure for the Tabernacle covering. In any case, the royal cubit was a natural choice for a project with religious significance.

A stronger clue comes some time later when Solomon, following David's divinely inspired directions (1 Chronicles 28:11) for the temple design, used 'the cubit after the first measure' (2 Chronicles 3:3). Which cubit was this? Obviously not the 'usual' cubit of the Hebrews; this was the common cubit according to biblically late archaeological evidence like the Siloam tunnel.[21] So it must have been the royal, the same one Moses used for the Tabernacle and Ark of the Covenant (i.e. from Solomon's perspective, the 'old' measure). Perhaps the royal cubit was the 'correct' one for temples, something even the Egyptian pagans understood. Scott's zeal for the common cubit leads him to claim the Bible made a mistake regarding Solomon's bronze sea (Appendix 2), but Zuidhof [22] makes a better case for Solomon using the royal cubit.

The strongest clue is in Ezekiel's vision, where an angel measures the temple with a reed (rod) of 6 cubits, each a 'cubit plus a handbreadth' (Ezekiel 40:5, 43:13). Amazingly, some have argued against this being a definition of the royal cubit, but to Ezekiel's audience (which includes us), there is probably no better way to say 'Royal Cubit'. It was always one handbreadth longer than the common cubit in both Egypt and Babylon.

Since God specified royal cubits for the future temple, there's a good chance he specified the same for Solomon's Temple.[23] It was the cubit of choice for ancient and impressive constructions of early Egypt and Babylon—especially anything religious.

Noah's Ark was divinely specified, big and early—a perfect candidate for the royal cubit.

Clues for a Babel origin of royal cubits

The Royal Egyptian cubit attracts all kinds of weird and wonderful speculations about its origin. Here are some historical clues for a more down-to-earth starting point for all the royal cubits; they trace back to the cubit used at Babel.

The royal appears in ancient architecture. State sponsored project like palaces, tombs and temples used the royal cubit. Nowhere is this more obvious than in the ancient monuments at Giza, proclaiming the REC with stunning accuracy. Egypt has the double advantage of colossal stone constructions and preservation in a dry climate.

Mysterious royal cubit origin. 'The anatomical length … cannot possibly be as long as the royal cubit of 525 mm.'[24] (Unless, of course, it came from a people taller than the Egyptians.) Egyptian royal cubits had seven palms and 28 fingers in a cubit. The Babylonian had 30 divisions, which makes a lot more sense for fractions like □. It is easier to believe Egypt started with the same royal length and made their divisions later.

Table 3. Uniformity of royal/architectural cubits.

Civilization	Length (mm)
Mesopotamia	522–532
Persia	520–543
Egypt	524–525

Respect for the royal cubit. This indicates an important legacy, like a standard handed down from the 'gods'. The 'gods' of certain cultures could be early post-Flood founders a few generations after Noah.[25] In Egypt, building overseers required the REC to be calibrated against a precision standard at regular intervals. Failure to do so was punishable by death.

Mother of the Arm. The Hebrew for Cubit is 'ammah', derived from mother, as in 'mother unit of measure'. The same word is used throughout the Old Testament as a unit of length. This could convey the idea of a measurement passed down from an ancestor, who defined the original or 'mother' cubit—an ancient measure, even in Moses' day.

Uniformity of royal cubits (table 3). It is difficult to imagine how a supposedly non-anatomical measure could turn up in different nations with distinct subdivisions yet have a suspiciously similar length. If they were exaggerating in order to make their own king look the larger than life, why would the lengths be similar? There is even mention of English, Chinese and Mexican Aztec cubits within the range 518–531 mm (20.4–20.9 in).

Summary of problems with the 'common' cubits

Noah was no Hebrew. Later Hebrew constructions (such as the Siloam tunnel) confirm a common cubit, but Noah's Ark is unlikely to have anything to do with the length of a Hebrew cubit determined from the ruins in Palestine. Noah was no Hebrew; he built the Ark in a different country, at a different time and in a different world!

Too short for an antediluvian forearm. The Bible describes pre-Flood life spans approaching a thousand years. Combined with the thoroughly documented trend of larger-than-today fossils, it would be natural to assume the antediluvians were taller than we are today. Based on cubit ratio averages,[26] the short cubit gives a stature of around 1.67 m (5ft 6 in), which is less than a modern average man[27] despite 4,500 years of bondage to decay (Romans 8:21).

The Ark should be an ideal size. This may seem obvious: too large and Noah is wasting construction effort, too small and the voyage will be cramped. But an arbitrary choice of the smallest cubit ignores the potential explanatory power of a *best* cubit.

JEDP influence. Serious cubit studies are rather few, and R.B.Y. Scott has been the primary source for cubit information. As an advocate for the JEDP heresy, Scott assumes the Bible was a recent invention, written about the

time the Siloam tunnel was dug. But if Moses got the Ark's dimensions passed down to him (or retold by God himself), we don't bother rummaging around Palestine to find Noah's cubit. There are more ancient places to look.

A genuine 300 cubits. Noah was given the dimensions, but was this the internal or external size? The walls of the vessel could easily have been 1 cubit thick (planks, frames and ceiling), which immediately consumes 11% of the Ark's volume (now 298 x 48 x 28 cubits). Knowing this, Noah may have gone the extra distance to be sure he was meeting the specification. Along the same lines, if Noah used a cubit only 457 mm (18 in) long, was he doing an honest job? Surely he would use a genuine cubit, not the smallest one he could find.

Answering objections

The common cubit is older than the royal. They are both old. The assumption of an earlier 'common' cubit is based on a model of gradual development of civilization, not archaeological evidence. In Egypt, the royal cubit is clearly observed well before any 'certain vestiges of the small cubit have been recorded'.[24] Since the royal or building cubits are used in more impressive constructions than the common cubit, they sometimes imply the ancients came up with the longer cubit at a later date. The trouble is that few commentators are brave enough to postulate a rough date for the origin of the longer cubit standard. Chances are there isn't one, because it goes right back to the Flood.

Perhaps Noah was shorter than normal. At a sub-optimal 1.67 m (5ft 6 in), Noah would be out-of-place in the pristine antediluvian world.[28] He lived 20 years longer than Adam. Even today stature is used as an indicator of general health in a population. If Noah deliberately picked a short cubit (his own) when his ancestors towered over him, then this borders on the issue of 'dishonest measures' that God abhors. Noah cheating on the Ark dimensions!

The royal cubit was not a true anatomical cubit. We can't be sure the cubit-plus-handbreadth definition of the Royal Egyptian cubit is proof that the original came about that way. Whether it did or not, the big, important ancient structures used it, and so did the angel in Ezekiel's vision. Proof of a longer antediluvian forearm is not the central issue but simply a clue.

Moses converted the dimensions of Genesis 6:15. The Ark is stated in round numbers: 300 long, 50 wide and 30 high—excellent proportions for ship stability and sea-keeping performance.[29] God gave the dimensions to Noah and there is no indication that these whole numbers were later modified. Conversion from one cubit to another would produce messy numbers which, when rounded to only one significant figure, might no longer be optimal.

Noah's cubit has no reason to persist until the Babel Tower. The time gap is not very long, 101 years according to Ussher,[30] and even less to the *start* of the Babel project. It has already been shown that construction of Noah's Ark dictates standardization. After Babel, the early nations once again demonstrated extraordinary building prowess, even a zeal for metrology. So why should the intervening period be any different? While there were fewer people, the level of sophistication would not have been eliminated. Standards of measure have always been long lived, and how much more so when the originators of the civilization are still alive, and 'the people are one' (Genesis 11:6). To assume a common cubit for Noah's Ark and then switch to a royal cubit for Babel is inconsistent with the way the royal cubit remained accurate for thousands of years after this.

Under the JEDP spell?

Ironically, creationists have chosen the same cubit as the documentary theorists would advocate, yet the longer 'royal' cubits are a more natural choice. The Bible and objective scientific inquiry should direct creationists, but they seem to have reacted to the objections of skeptics and followed JEDP advocates up the garden path of the short cubit.

Now we have a cubit that is out of place in history, erasing the link between post-Babel constructions and Noah's Ark. Even the biblical preference for the long cubit has been ignored. The more modern 'common' cubit makes the antediluvians look short, and could even be viewed as an attempt to dodge an engineering problem. If we allow this cubit to define an undersize Ark when a larger Ark is more likely, we pay the price of incorrect structural calculations, wildly mistaken capacity, inaccurate illustrations and gamut of second-rate interpretations.

All this was for the sake of an alleged crowding problem that could only ever be resolved by the number of animals, not the length of the cubit.

Conclusion

Let's assume for a moment that Noah used a long cubit and the Ark was 157 m long. It should have been a perfect fit to keep Noah from wasting construction effort. Yet Woodmorappe easily fits the animals into an Ark defined by a 457 mm cubit. What happens if those animals are now loaded into an Ark with 50% more volume, based on a cubit closer to 520 mm? To be a 'perfect fit', there may have been more animals or larger cages or perhaps the Ark was not a box shape.

Is there a best royal cubit? Although the REC is accurately defined, and very likely close to Noah's cubit, I would suggest using the Nippur cubit standard of 518.5 mm. It is nearer to the geographic origin of the post-Flood world, is made of copper, and happens to be the oldest surviving standard. This cubit also counters the misconception that Moses was simply borrowing Egyptian cubits to describe Noah's Ark. Slightly conservative among the royal cubits, the Nippur cubit correlates to a stature of around 1915 mm (6 ft 3 in). In addition, the general consensus is that the cubit began in Sumeria, which happens to be where the Tower of Babel was.

Table 4. Common and royal cubits listed by Whitcomb and Morris.[31]

Class	Cubit	Cubit Length (mm)	Approx Stature (mm)	Ark Length (m)	Relative Length Change	Relative Volume Change	Relative Wave Load Change	Relative Stress Change
Common Cubits	Short Hebrew	445	1636	133	-3%	-8%	-9%	-1.7%
	Short Egyptian	447	1646	134	-2%	-7%	-7%	-1.4%
	Common Default	457	1683	137	0%	0%	0%	0%
Royal Cubits	Babylonian Royal	503	1852	151	10%	33%	37%	5.9%
	Long Hebrew	518	1907	155	13%	46%	51%	7.6%
	Royal Egyptian	524	1929	157	15%	50%	56%	8.2%

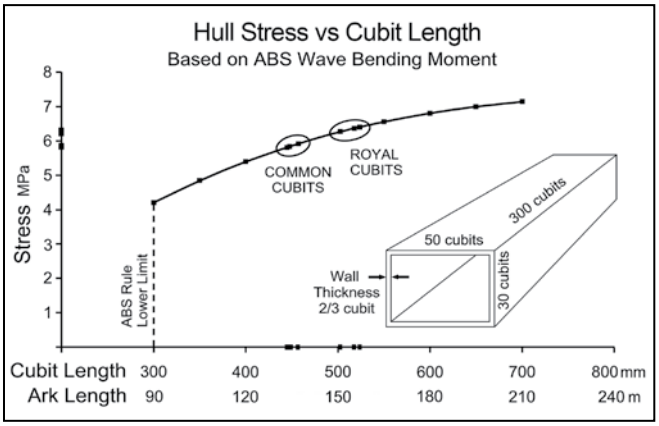


Figure 2. Hull stress vs cubit length based on ABS wave bending movement.

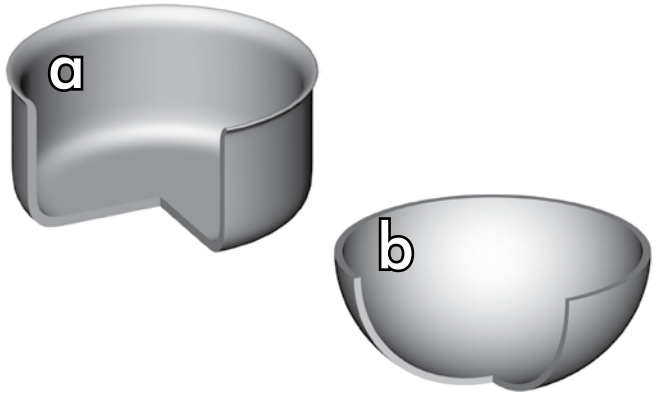


Figure 3. Solomon's Molten sea according to Zuidhof[20] (a) and Scott[3] (b). Figure 3a is based on Zuidhof's illustration.[20]

Appendix 1

How cubit length would affect the Ark

Table 4 shows cubits listed by Whitcomb and Morris,[31] and the effect of a change from the default cubit of 457mm (18 in). For a male adult the cubit is assumed to be 27% of stature.

Hull stress vs cubit size. The hull is a simplified rectangular tube of constant proportions approximately Noah's Ark at various scales. For ships over 90m long in unrestricted seas, the ABS rule for wave bending moment establishes the hull's necessary bending strength as a function of the vessel's length, breadth and hull form (figure 2).

Appendix 2

The royal cubit for Solomon's Sea

Taking a roughly cylindrical model of the vessel (figure 3a), Zuidhof confirms that the volume (2 Chronicles 4:5, 1 Kings 7:26) fits with a diameter (2 Chronicles 4:2, 1 Kings 7:23) measured in royal cubits.[20] Astonishingly, Scott (using a hemispherical model, figure 3b) attempts to force a common cubit into the text despite arriving at an oversized cubit (22.06 in) in his calculation;

> '… a figure impossible to relate either to the cubit of the Siloam tunnel or to a seven-palm cubit of 20.4 in'.[32]

To solve his dilemma, Scott points the finger at some unknown 'ancient scribe' who allegedly '… used by mistake the formula for the capacity of a sphere instead of that of a hemisphere'.

Not only does Scott deny Moses' authorship of the Pentateuch, but he makes out Solomon's handiwork was nothing but a dim memory. This is JEDP thinking at its worst, and destroys any chance of a mathematically challenged 'ancient scribe' coming up with the Ark's optimal specifications.

References

1. The cubit is also called *ell* (as in elbow). The Greek *pechus* (LXX) also refers to the forearm. The original Hebrew is *ammah* or 'mother of measure' (Strong's), and is similar to Assyrian *ammatu* (BDB Hebrew Lexicon). All clearly refer to cubits.
2. Whitcomb, J.C. and Morris, H.M., *The Genesis Flood,* Presbyterian and Reformed Publishing Co., NJ, 1961.
3. Scott, R.B.Y., Weights and Measures of the Bible, *The Biblical Archaeologist* **XXII**(2):22–27, 1959.

4. The only exceptions are Collins, Woodmorappe and Gitt, but their sources, like Scott, are explicitly stating measurements that post-date Noah and the Babel dispersion by millennia; e.g. buildings in Palestine and the Siloam tunnel.
5. The Siloam Inscription commemorates the completion of 'Hezekiah's tunnel' built by Judah's king Hezekiah (2 Kings 20:20, 2 Chronicles 32:30, dated 727 to 698 BC; Ussher, *The Annals of the World*, 715 to 686 BC, *Baker Encyclopedia of the Bible*, 1988). Rogerson and Davies argue for an even later (Hasmonian) date. Rogerson, J.W. and Davies, P.R., Was the Siloam Tunnel Built by Hezekiah? *Biblical Archaeologist* **59 S**:138–149, 1996.
6. Scott, ref. 3, p. 32, 'IV Weights'. Scott uses Exod 38:25–26 to link the talent to the shekel: '… it is clear that (for the writers of the Priestly document of the Pentateuch, at least) there were 3000 shekels to the talent'.
7. Personal e-mail from Dr John Morris; cited by permission, 27 July 2004.
8. Woodmorappe, J., *Noah's Ark: A Feasibility Study,* ICR, CA, p. 7, 1996.
9. Ramm (cited 40 times in *The Genesis Flood)* supposes a Caucasian-only flood event (a form of local flood dogma), and considers death and suffering to be part of God's original creation, i.e. 'Evil is inherent in nature'.
10. The Hong study used a metric approximation of Scott's 445 mm cubit. Their Ark of 13.5 m depth, 22.5 m breadth and 135 m length implies a unique cubit of 450 mm.
11. Woodmorappe, ref. 10, p. 10. 'There were nearly 16,000 animals on the Ark'. A rounded figure based on Table 1, p. 10, 'Total 15,754'.
12. Whitcomb and Morris, ref. 2, p. 69. '… at the outside, there was need for no more than 35,000 individual vertebrate animals on the Ark'.
13. *ABS Rules for Building and Classing Steel Vessels 2004*, Part 3 , Chapter 2, Section 1, Subsection 3.5.1, Wave Bending Moment Amidships. Formulae and calculator accessible at: <www.worldwideflood.com/ark/hull_calcs/wave_bm1.htm>, Dec 2005.
14. Levanthes, L., *When China Rules the Seas*, Oxford University Press, UK, pp. 75–85, 1994 (Illustration p. 21). The largest wooden vessels on record are the 15th century Chinese treasure ships of Cheng Ho. Chinese records pointing to ships over 152.4 m long were dismissed as exaggeration, but the discovery in 1962 of an oversize rudder post lent support to the claim.
15. Seakeeping refers to how a ship responds in the waves or the ability to navigate safely at sea especially in stormy weather. This is a broad term, encompassing both motions and general safety (like tendency to broach).
16. There are upper and lower bounds to antediluvian technology. The Ark was only made of wood, not a superior material like steel. No other ships survived, indicating the antediluvians were not overly 'high tech'. In addition, Noah cannot be too far above his peers since Solomon was wiser than him (1 Kings 3:12) and we know what Solomon could do—although some account should be made of Noah's much longer working lifetime. Lastly, examples of baffling ancient technology (e.g. Egypt) should remind us not to underestimate the technology of Noah's day, which would be even more comprehensive prior to the Flood.
17. The Royal Egyptian cubit spanned thousands of years and varied less than 5%.
18. The Royal Egyptian cubit of 524 mm has been accurately determined not only from the constructions themselves, but also from actual cubit standards left behind by the ancient craftsmen. In 1877, Petrie published his findings, saying that 'about a dozen of the actual cubit rods that are known yield 20.65 ± .01 in', a value still considered accurate today. Egypt has the earliest architectural evidence from which a cubit can be securely established.
19. Cubits in Mesopotamia are rare. Wooden 'cubit rods' decay in the wet soil, so the length is obtained from buildings assumed to be laid out in cubits. A copper standard dated around 1950 BC was unearthed at Nippur defining a Sumerian cubit (kù) of 518.5 mm. The general picture is that cubits outside of Egypt were less exact.
20. Zuidhof, A., King Solomon's Molten Sea and Pi, *Biblical Archaeologist* **45**:179–184, 1982. On p. 180 Zuidhof says that 'cubits of the old standard: could hardly mean anything other than a reference to the so-called Cubit of Moses, the standard employed in the construction of the tabernacle. We may assume that the Hebrews used cubit rods derived from the Royal Egyptian Cubit of seven handbreadths, as their craftsmen had originally learned their trade in Egypt.' However, Unger's Bible Dictionary argues that the 'extraordinary number of sexagesimal ratios, … points to Babylonian influence'. Whether Solomon used the 7 palm, 28-finger REC or the 30 finger Babylonian, it was still a 'royal' length.
21. The Siloam Tunnel measurement is definitely a common cubit, but it is not necessarily precise. For example, unlike a building, why should the length of a tunnel be a round number?
22. Zuidhof, ref. 20, pp. 179–184.
23. Weighs and Measures, *The Jewish Encyclopedia*, Singer, I. (Ed.), Funk and Wagnalls, p. 483, 1901, <www.jewishencyclopedia.com/view_page.jsp?artid=81&letter=W&pid=0>, 14 May 2006: 'The fact that Ezekiel measured the Temple by a special ell is comprehensible and significant only on the assumption that this ell was the standard of measurement of the old Temple of Solomon as well.'
24. Legon, J., The cubit and the Egyptian Canon of Art, *Discussions in Egyptology* **35**:61–76, 1996, <www.legon.demon.co.uk/canon.htm>. Here Legon is summarizing Lepsius who claimed that the seven divisions of the royal cubit are so awkward and unnatural they can't have been practical (Lepsius, R., *ZAS* **22**:6–11, 1884).
25. There are clues that in certain cultures, early post-Flood ancestors were remembered with god-like status, e..g. 'ancestral gods of the nation'. Cooper, B., *After the Flood,* New wine Press, England, p 105, 1995.
26. The cubit varies with stature, but what is a typical ratio? The Mishna (Jewish writings) gives the height of a man as 4 cubits, a ratio of 25%. Pearson tabulated data from Galton (350 adult males, ratio 26.9%), Macdonell (3,000 prison inmates, ratio 27.1%) and Shuster (Oxford students, ratio 26.9%). So 27% is reasonable. Pearson, K., *The Life, Letters and Labours of Francis Galton*, vol. IIIa, Cambridge University Press, England, p. 54, 1930.
27. Using a 27% cubit to stature ratio, the 457mm (18in) cubit gives a stature of 1693mm (5ft 6 1/2in). According to NHANES III Survey conducted in the USA in 1988–1994, this would be the shortest white male in every ten today.
28. A short Noah? The illustrations by E. and B. Snellenberger in: Clannin, G., *In the Days of Noah*, Master Books, Green Forest, AR, 1996., show Noah obviously shorter than Shem (p. 12 and cover), as well as his grandfather Methuselah (p. 24). A diminutive Noah is probably not what Whitcomb and Morris had in mind in 1961.
29. Hong, S.W. *et al*., Safety investigation of Noah's Ark in a seaway, *Journal of Creation* **8**(1):26–36, 1994.
30. Ussher, ref. 5, lists the Babel Tower at 1757 AM, 101 years after the Flood. Ussher uses the naming of Peleg as a reference to the Babel dispersion (Gen 10:25), which is the prevailing view. Even if this date were wrong, a longer time span would clash with early civilizations like Egypt which had to get underway soon after Babel.
31. Whitcomb and Morris, ref. 2, p. 10.
32. Scott, ref. 3, p. 26.

Tim Lovett has a bachelor's degree in Mechanical Engineering from Sydney University, Australia, and a graduate diploma of Technical Education. He worked for a number of years on the design of diagnostic ultrasound equipment and was an instructor for 12 years in technical college engineering courses. He is now fully involved with the Noah's Ark Exhibit at the Answers in Genesis Creation Museum.