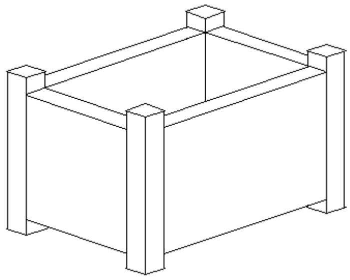
Prototype lorry trailer development

I spent my Year in Industry placement under supervision of Bachrun Mason in the Design/Analysis/Test department at the Telford plant of GKN AutoStructures, an automotive chassis components manufacturing company. I found it surprising the amount of mathematics I used at work having expected never to use school level calculations again.

The most recent problem I had was part of a project I was involved in; we needed to do some testing on a development prototype lorry trailer. On some of the testing the trailer had to be empty, and on others it had to be laden (weighted with 32 tonnes, as if carrying the maximum legal load of cargo in the UK).

We decided to use 16 masses of 2 tonnes each that could easily be applied to the trailer via a forklift but we would have to make them ourselves.



The easiest and most cost effective method of acquiring such weights was to use 16 solid steel stillages (crates) of which the site already had thousands of various sizes used to store all kinds of automotive components the factory produced, and fill them with enough concrete to make them 2tonnes each.

The first thing I would need to do was find out the volume of concrete I would need for each stillage;

1tonne = 1000kg

Density of concrete:
2240 - 2400kg/m^3
∴ Average Density:
2320kg/m^3

Weight of Stillages:
300kg

$$\frac{Mass\ (m)}{Volume\ (V)} = Density\ (\rho)$$

$$Volume\ of\ Concrete\ needed\ (V) = \frac{m}{\rho}$$

$$= \frac{Mass\ of\ Concrete\ needed}{Density\ of\ Concrete}$$

$$= \frac{2tonnes - 300kg}{\frac{2320kg}{m^3}}$$

$$= \frac{1700kg}{2320kg/m^3} \qquad = 0.7328m^3$$

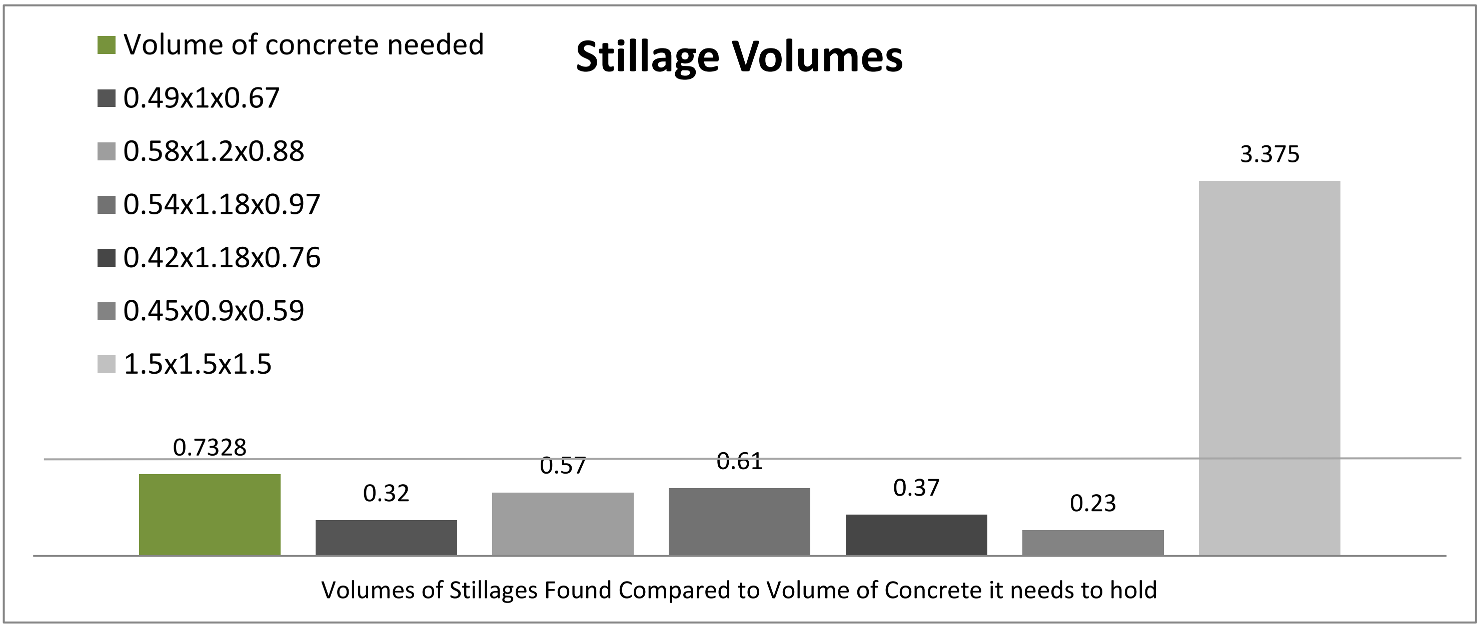
The stillage most readily available to our area was the one Bachrun had planned to use; 1.5m x 1.5m x 1.5m. However after carrying out the calculations;

$$Volume = width\ x\ depth\ x\ height$$
$$0.7328m^3 = 1.5m\ x\ 1.5m\ x\ height$$
$$0.7328m^3 = 2.25m^2\ x\ height$$

$$\Rightarrow height = \frac{0.7328m^3}{2.25m^2} = 0.3257m$$

I found that were we to use these stillages, a pool of concrete just 0.3257m (32.6cm) would sit in the bottom of a container 1.5m high. Meaning a lot of waste and although having the centre of mass of the weight that low could be a benefit when on the trailer for stability, it would make such an un-even load dangerous to lift with a forklift.

I now needed to find the optimum sized stillage on site that would hold $0.7328m^3$ of concrete without leaving too much empty space inside. I scoured the site with a tape measure for suitable stillages of around the right size ensuring to take dimensions from the inside.



The graph shows among other things, that I need to keep looking for the appropriate size!

The idea of the sized stillage I was looking for was obviously too small as all 5 I found aren't big enough to hold my 3/4s of a metre squared of concrete.

In the chart the first column is the volume of concrete I need to be able to hold, the subsequent 5 columns are the details of the stillages I thought would be appropriate in format height x width x depth, and the last column is the 1.5m x 1.5m x 1.5m stillage we were initially going to use.

I need a stillage whose capacity is just above that of the first column; meaning I would be able to hold the correct amount of concrete, but have the level just shy of the brim. I'll keep looking!