BCATS. 29681

BCATS
BUILDING, CONSTRUCTION AND ALLIED TRADE SKILLS

Measure & Calculate

Measure and calculate for a Stage 3 BCATS project.

3 CREDITS

BCITO
He Hunga Hanga Mātou
building people

Te Pūkenga

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Introduction

No matter what Building, Construction and Allied Trades Skills (BCATS) project you do, you will need to measure and calculate throughout.

This handbook contains calculations commonly used in the building and construction industry. They will help you perform measurements and calculations needed for your project and be a reference if you go into the trades after school.

A successful BCATS student...

Knows:

- How to understand the nature and scope of a job
- The right tools to use for a job
- The standard that is expected for a finished job
- When to ask questions and when to give advice
- The skills needed to complete a job

Does:

- Turn up on time every day
- Follow instructions
- Follow Health and Safety procedures and show 'due care'
- Their work in a timely manner and to a high standard

Is:

- Honest and trustworthy
- A good timekeeper
- A team player
- Willing to learn
- Hardworking
- A confident communicator

Outcome

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Measure and calculate for a Stage 3 BCATS project

Evidence requirements

1.1	Required measurements and calculations are determined.
1.2	Mathematical methods that are chosen are appropriate for the required measurements and calculations.
1.3	Chosen methods are applied in the context of the situations provided.
1.4	Measurements and calculations are undertaken and are accurate and consistent with the requirements of the Stage 3 BCATS project.
1.5	Information and results are accurately presented in accordance with workplace practice.

Assessment evidence and judgement

Evidence that you can make accurate measurements and calculations should be collected as you do your project. Some of this will come from the project documentation you develop and use. Other evidence will come from the project itself, which you will need to take photos of.

You can also record measurements and calculations in your Student Work Diary. You will need to pay special attention to including evidence that you:

- used correct mathematical methods to measure quantities and materials
- used correct tools to determine how and what to measure or calculate
- chose methods which are relevant and appropriate to the project and the BCATS environment
- have taken wastage into consideration when coming up with your final figures.

Depending on your project, you could include cutting lists, order lists, quantities lists, costings and plans as evidence. Remember to keep your project documentation updated to reflect any changes to the original measurements and calculations.

You need to understand why and how calculations are made. However, just like many tradespeople, you can use calculators and other technology (eg computers, apps) to check or make the actual calculations.

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Building mathematics

In the building and construction industry, being able to take measurements and accurately calculate can be the difference between a successful project and a disaster, and between losing money or making a profit.

A good understanding of practical building mathematics is the tool that makes sure your mortar sets (ratios) and your right angles are 'true' (Pythagoras theorem).

Linear measurements

Linear measurements are all about your tape measure. Here are some of the basics that you need to know to make sure you record and read measurements correctly:

1 metre = 1000 millimetres	This can be written as: 1m 1000mm
1 millimetre = 1/1000 of a metre	This can be written as: 1mm 0.001m

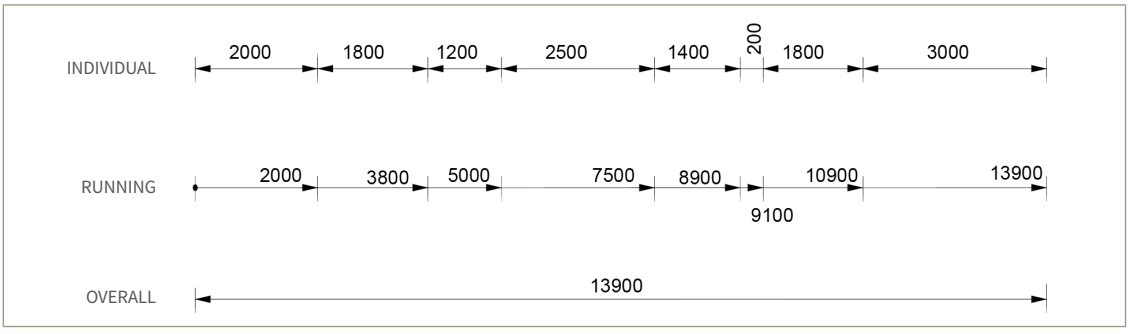
A measurement of 3 metres and 200 millimetres can be written as:

3.2m or

3200mm

There are three types of measurement used in the construction trades:

- → **Individual** the distance between two fixed points
- → **Running** the sum of individual measurements from a given point
- → **Overall** the sum total of the individual or running measurements.



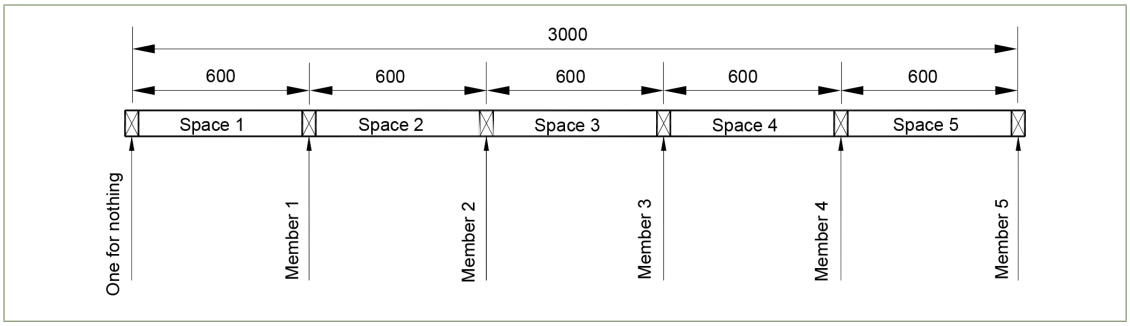
Spacings

Calculating the correct spacings between reinforcing or even just knowing where the framing members are on a building can be calculated in a couple of different ways. The two that most BCATS trades use are:

- One for nothing
- Centre to centre.

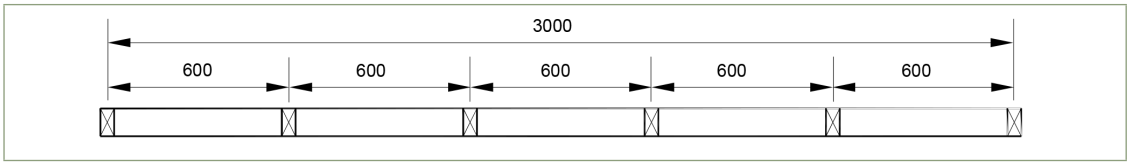
One for nothing

One for nothing means that the first framing member in a wall has no span or space associated with it, but still needs to be counted to make sure that there are the correct number of framing members. In the example below, a 3000mm long wall with stud spacings at 600mm has five framing members associated with it. But actually there are six framing members required. This sixth member is called “one for nothing”.



Centre to centre

Centre to centre measurements are when you measure to the middle of a framing member or the position of reinforcing.



Area

Area measurement is the measurement of a surface area. You see an area measurement written as square metres or m^2. Area measurement are used a lot in the building and construction trades. They are used for calculating quantities of materials, building coverage and also pricing.

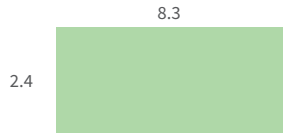
Here are some of the basics for calculating area.

Area of a square:

Area of a square = length x width
= 2.6 x 2.6
= 6.76m^2

Area of the square is 6.76 square metres

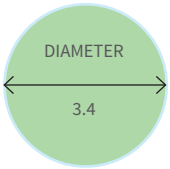
Area of a rectangle:

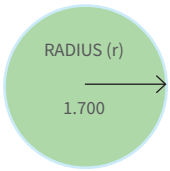


Area of a rectangle = length x width
= 8.3 x 2.4
= 19.92m^2

Area of the rectangle is 19.92 square metres

Area of a circle:





Area of a circle = πr^2
= 3.142 x r^2

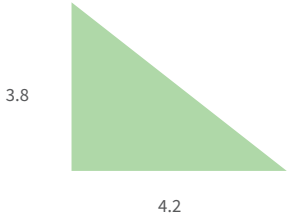
Radius (r) = diameter ÷ 2 (or half the diameter)
= 3.4 ÷ 2

r = 1.7

Area = 3.142 x 1.7^2
= 3.142 x 2.89
= 9.08m^2

Area of the circle is 9.08 square metres

Area of a triangle:



Area of a triangle = ½ the length of the base x height
= ½ b x h
= (4.2 ÷ 2) x 3.8
= 2.1 x 3.8
= 7.98m^2

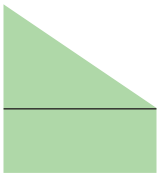
Area of the triangle is 7.98 square metres

Complex shapes:

It would be nice if all areas neatly fitted into the shapes above but the reality is they don't. When you have irregular shapes, you need to break them into shapes that you can calculate the area of.

For example, an area that looks like:

can be divided into a triangle and a rectangle like this. Once you have the area of both the triangle and the rectangle, you add the two totals together and this is the total area

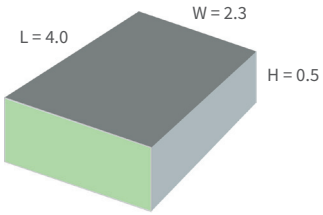


Volume

Volume is the amount of space that an object takes up. You see volume written as cubic metres or m^3. Volume is used to calculate things such as the amount of concrete or fill needed.

Volume of 3D rectangle:

To calculate the volume of a three dimensional rectangle you multiply the length, by the width, by the height (length x width x height).

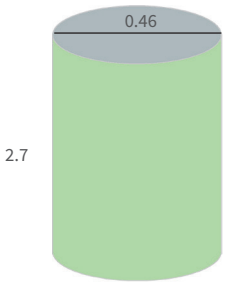


For example = L x W x H
= 4x 2.3 x 0.5
= 4.6m^3

Volume is 4.6 cubic metres

Volume of a cylinder:

To calculate the volume of a cylinder multiply the area of the circle (πr^2) By the height.



For example = πr^2 x Height
= (3.142 x 0.23^2) x 2.7
= (3.142 x 0.0529) x 2.7
= (0.1662) x 2.7
= 0.4487m^3

Volume is 0.4487 cubic metres

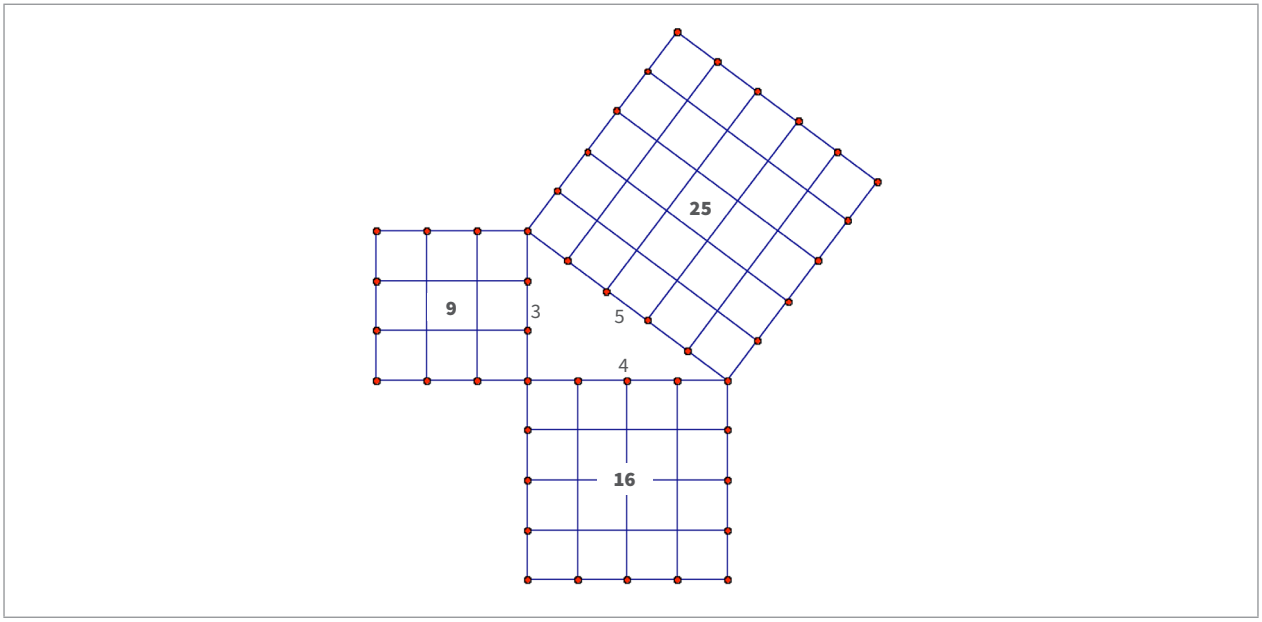
Pythagoras theorem

No construction text book is complete without including the Pythagoras theorem. Pythagoras falls under the mathematics subject of Trigonometry. Trigonometry is about the calculation of unknown sides and angles of triangles. This is important because it allows us to know if something is a right angle or not.

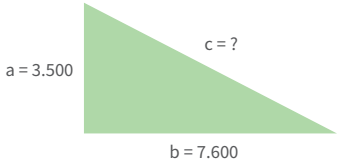
Pythagoras Theorem states that the square of the hypotenuse of a right angled triangle is equal in length to the sum of the square of the other two sides. The hypotenuse is the longest side of a right angled triangle.

In other words, it is the side of the triangle opposite the right angle.

This can be illustrated by the concept called "3,4,5" which is shown in the diagram below. The ratio between the sides of the rightangled triangle is always 3:4:5.



Pythagoras example:



Find the length of side c in a right-angled triangle

$c^2 = a^2 + b^2$

$= 3.5^2 + 7.6^2$

$= 12.25 + 57.76$

$= 70.01$

$c = \sqrt{70.01}$

$= 8.367$

Length of side c is 8.367 metres

Fractions and percentages

Fractions

To calculate the fraction of a quantity:

To calculate the fraction of a quantity multiply the top line of the fraction with the quantity and then divide by the bottom line of the fraction

Find ⅔ of 450 litres

$$= \frac{2 \times 450}{3}$$

$$= \frac{900}{3}$$

$$= 900 \div 3$$

$$= 300$$

⅔ of 450 litres is 300 litres

Percentages

Percent means "out of 100". Percentages are needed for all sorts of things including proportional quantities of materials needed, such as for making mortar or plaster and for thinning paint.

Here are some basics around working out percentages.

Percentages from decimals and fractions:

Multiply by 100

Fractions

$$= \frac{4}{5}$$

$$= \frac{4}{5} \times \frac{100}{1}$$

$$= \frac{400}{5}$$

$$= 80\%$$

⅘ as a percentage is 80%

Decimals

$$= 0.65$$

$$= 0.65 \times 100$$

$$= 65\%$$

0.65 as a percentage is 65%

Calculating percentages of quantities:

Multiply the quantity by the percentage

What is 40% of 50 metres

40% = $\frac{40}{100}$

= $\frac{40}{100} \times \frac{50}{1}$

= $\frac{2000}{100}$

= 20m

OR

= 0.4 x 50

= 20m

40% of 50 metres is 20 metres

Increasing percentages:

Multiply the amount you have by the percentage you want to increase it by and add that amount to the original

Increase 350m by 20%

20% = $\frac{20}{100}$

= $\frac{20}{100} \times \frac{350}{1}$

= $\frac{7000}{100}$

20% = 70m

OR

= 0.2 x 350

= 70m

Add % to original = 70 + 350

= 420m

350 metres plus 20% is 420 metres

Decreasing percentages:

Multiply by the amount you have by the percentage you want to decrease it by and subtract that amount from the original

Decrease 120m by 15%

15% $= \frac{15}{100}$

$= \frac{15}{100} \times \frac{120}{1}$

$= \frac{1800}{100}$

15% = 18m

OR

= 0.15 x 120

= 18m

Subtract % from original = 120 - 18

= 102

120 metres less 15% is 102 metres

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