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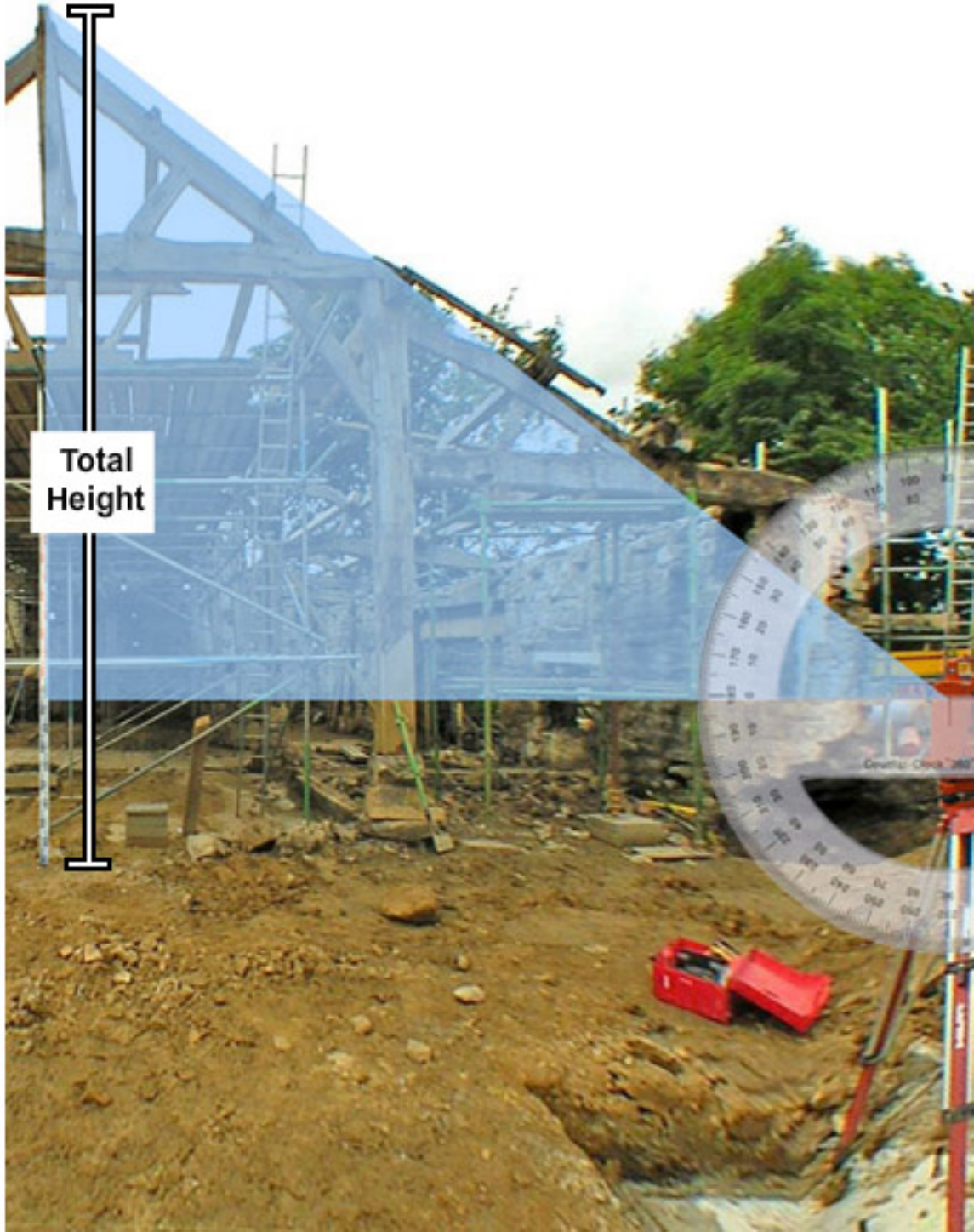
We will use a theodolite to calculate the **total height** of the building.



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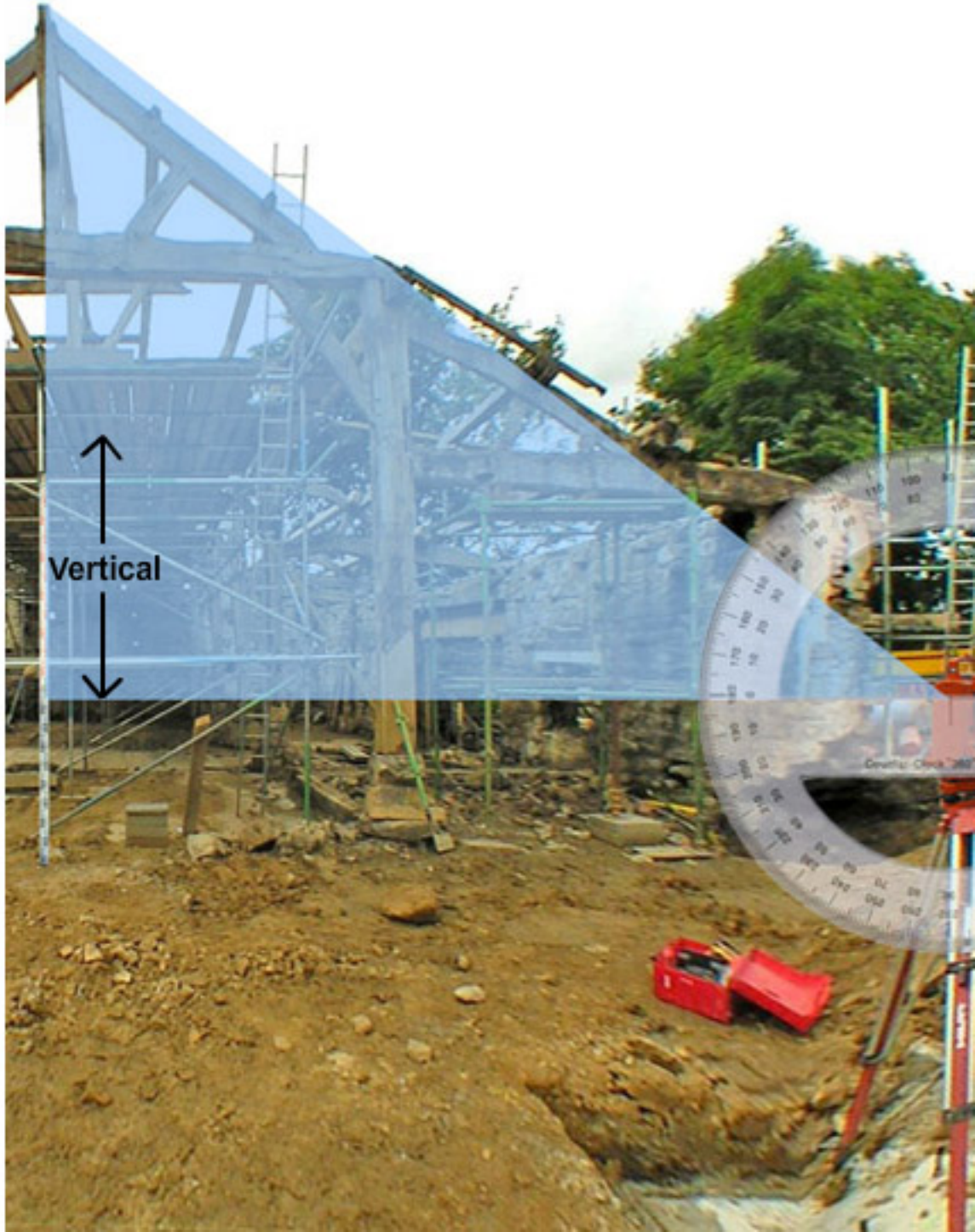
We also use a **levelling staff,** which is a large ruler.

It is placed **vertically**, directly under the tallest point of the building.

The distance between each large number on the staff represents 100 millimetres or 0.1 metre

Each block represents 10 millimetres

The staff is printed in black and red to help distinguish between the metre sections.



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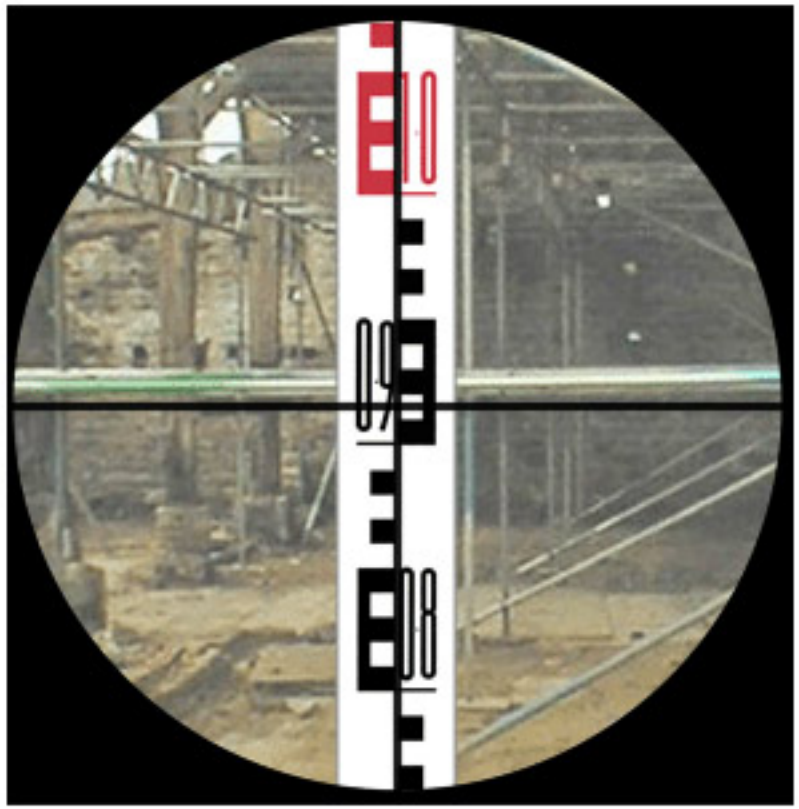

We align the theodolite view **horizontally,** then focus onto the staff.

What is the staff reading? (3dp)

_____ m

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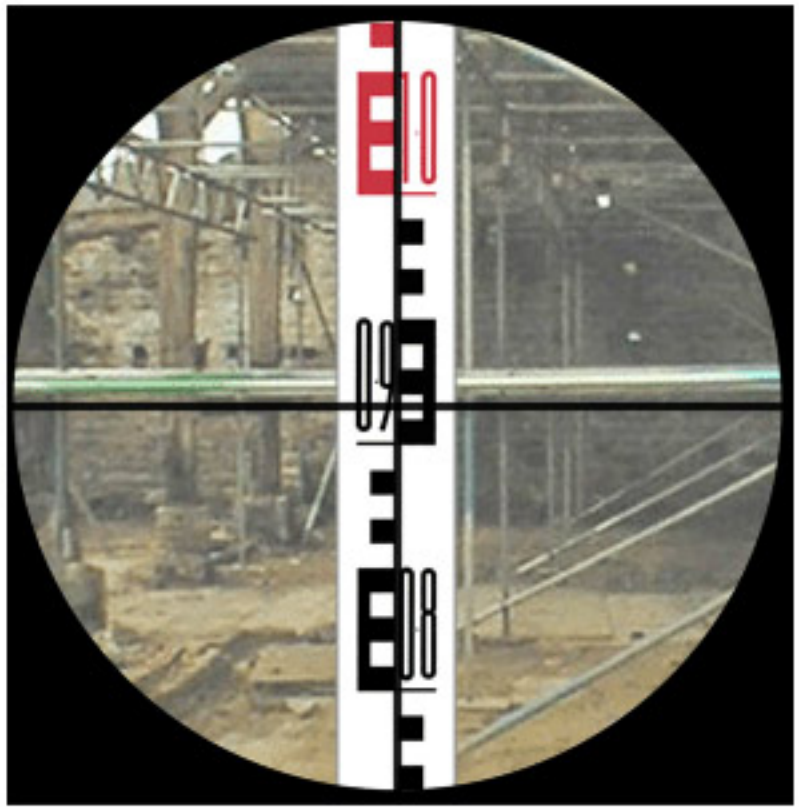

The reading of **0.915m** we took from the staff is the distance from the ground to the bottom of the blue triangle.

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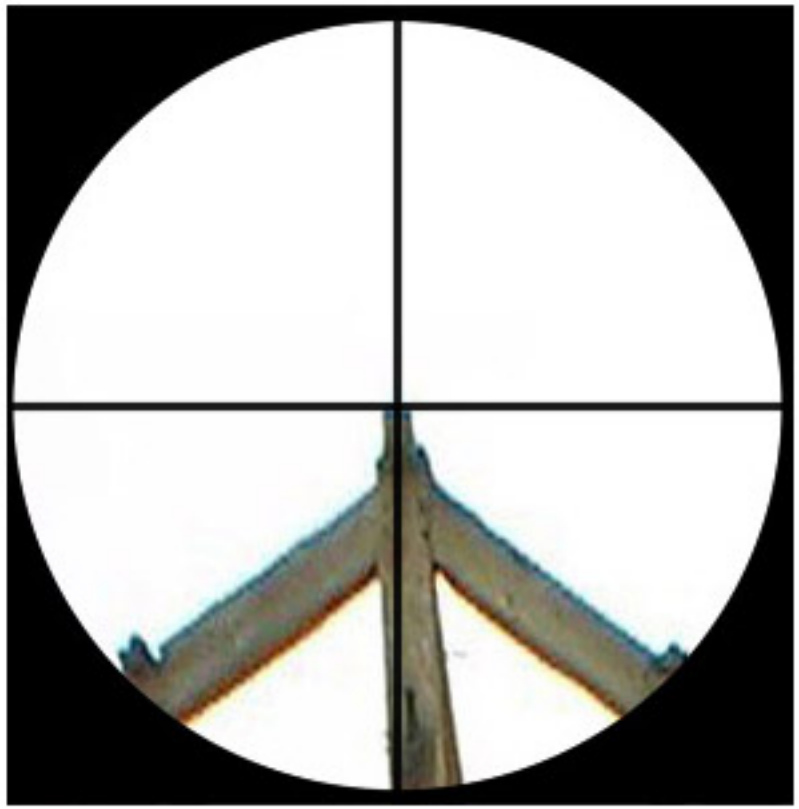

We then point the theodolite viewer at the top of the building and align the crosshairs to it.

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The theodolite display gives a digital readout of the angle between horizontal and the top of the building.

It measures angles from its central axis, which its telescope rotates around.

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The angle between horizontal and the top of the building that the theodolite has measured is represented in the diagram above.

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The angle is a **rotation** from

0 degrees (horizontal)

to the **'Line of Sight' to the top of the building**

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What is the angle?

degrees

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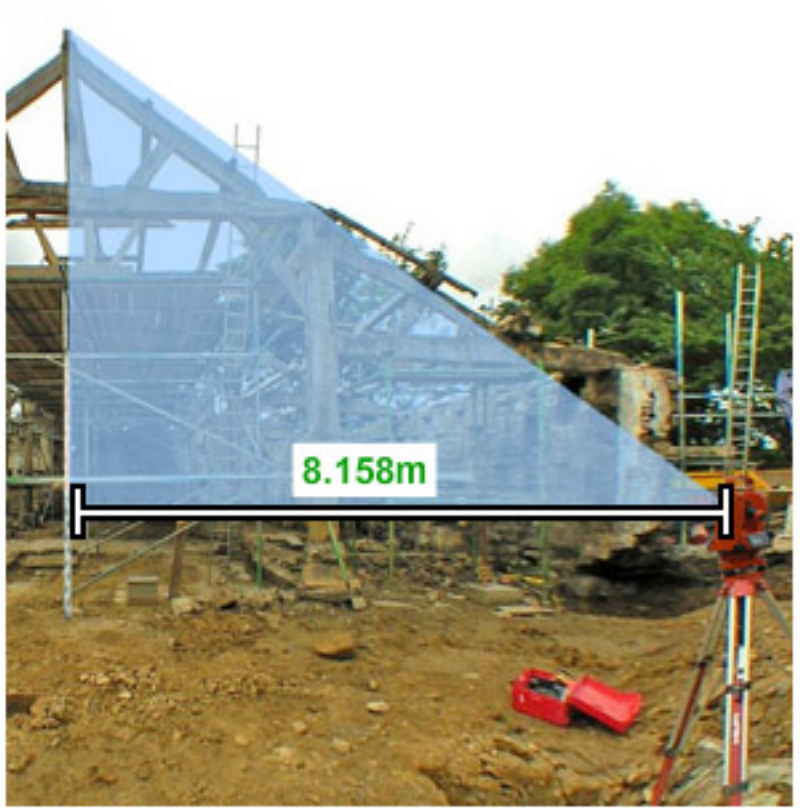

Next we need to measure the distance from the centre of the theodolite to the staff.

To do this we can use the theodolite, or a laser measuring device, or a tape measure.

The distance in this case is **8.158m**

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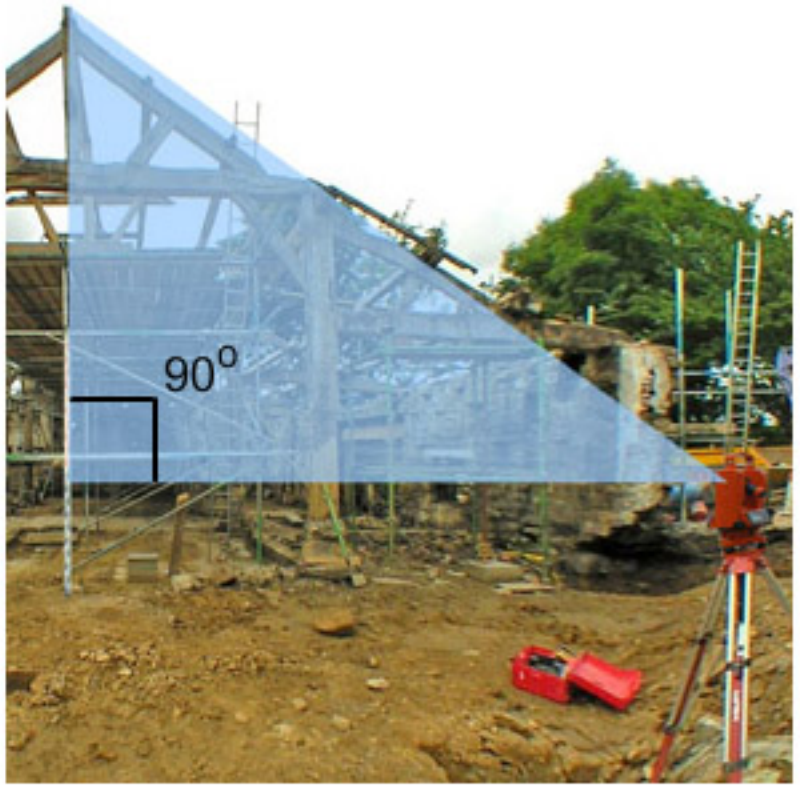
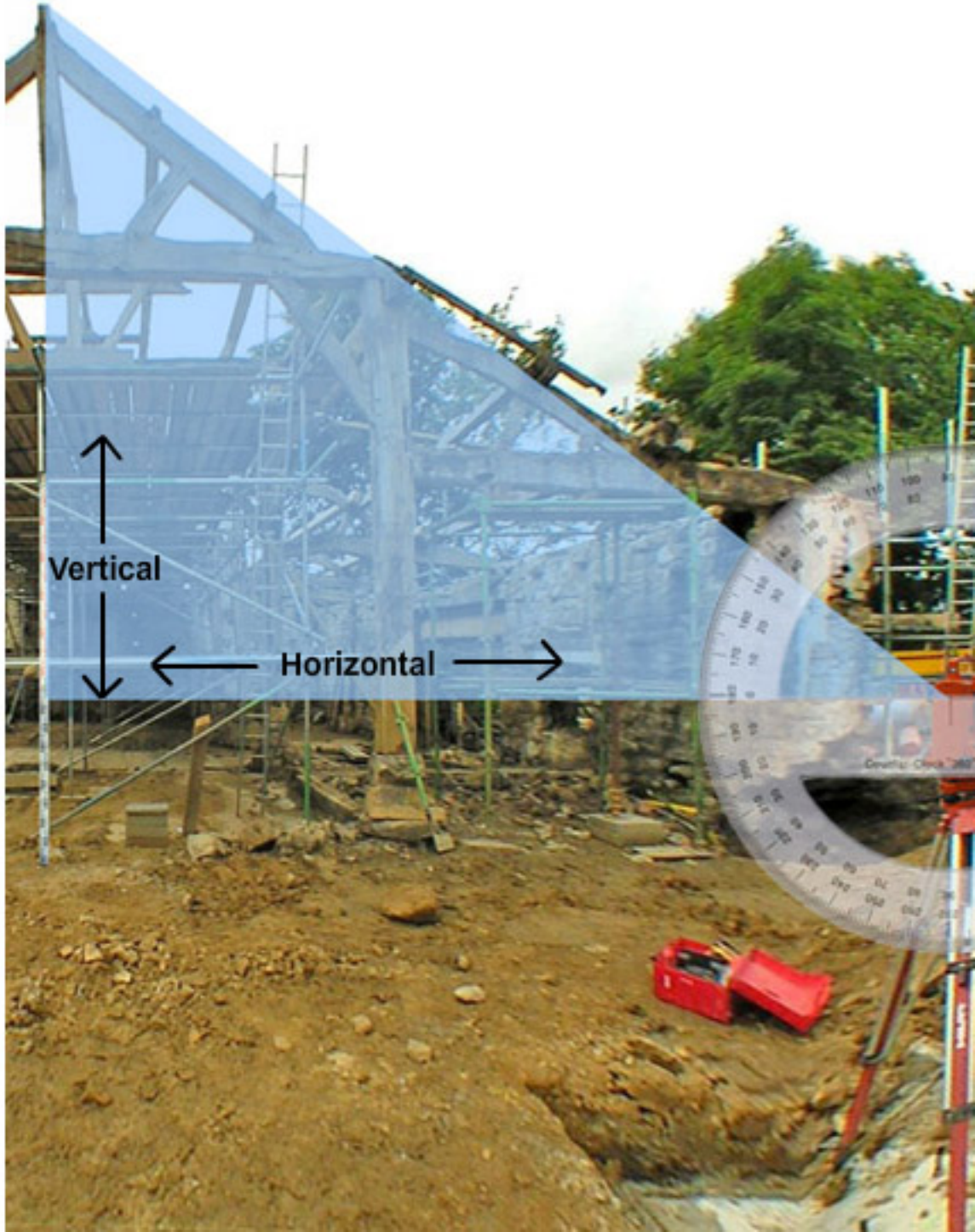


We know the theodolite was aligned **horizontally** to the ground when the staff reading was taken. We also know the staff is aligned **vertically** to the ground.

Therefore, the angle between the initial theodolite angle and the staff is a right angle, which is 90 degrees. This means the blue triangle is a **right-angled triangle**. We can use **trigonometry** to calculate the height of the building.



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θ (theta) is the mathematical symbol used to represent the angle between the **hypotenuse** and the **adjacent** lengths of the triangle.

Because we have measured the **adjacent** length and the **theta** angle, we can work out the length **opposite** the angle using this formula:

$$\text{Tan}\ \theta = \frac{\text{opp}}{\text{adj}}$$

We know the value of θ and adj but we don't know the value of opp so we rearrange this formula as:

$$\text{Tan}\ \theta \times \text{adj} = \text{opp}$$

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In the previous slide we saw that:

Tan θ x adj = opp

We know that the adjacent length is 8.158m

and the θ (theta) angle is 36 degrees

Applying these figures to the formula gives:
Tan 36 x 8.158m = opp

You will need a scientific calculator
to calculate opp

Press the [tan] button on the calculator,
then enter 36 (On some calculators you may
need to do this in the opposite order)
Then multiply by 8.158

What is opp to 3 decimal places?

_____ m

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In the previous slide we calculated the **opposite** length to be:

5.927m

We now add the reading from the theodolite we took earlier, which is the distance from the ground to the bottom of the blue triangle. This is:

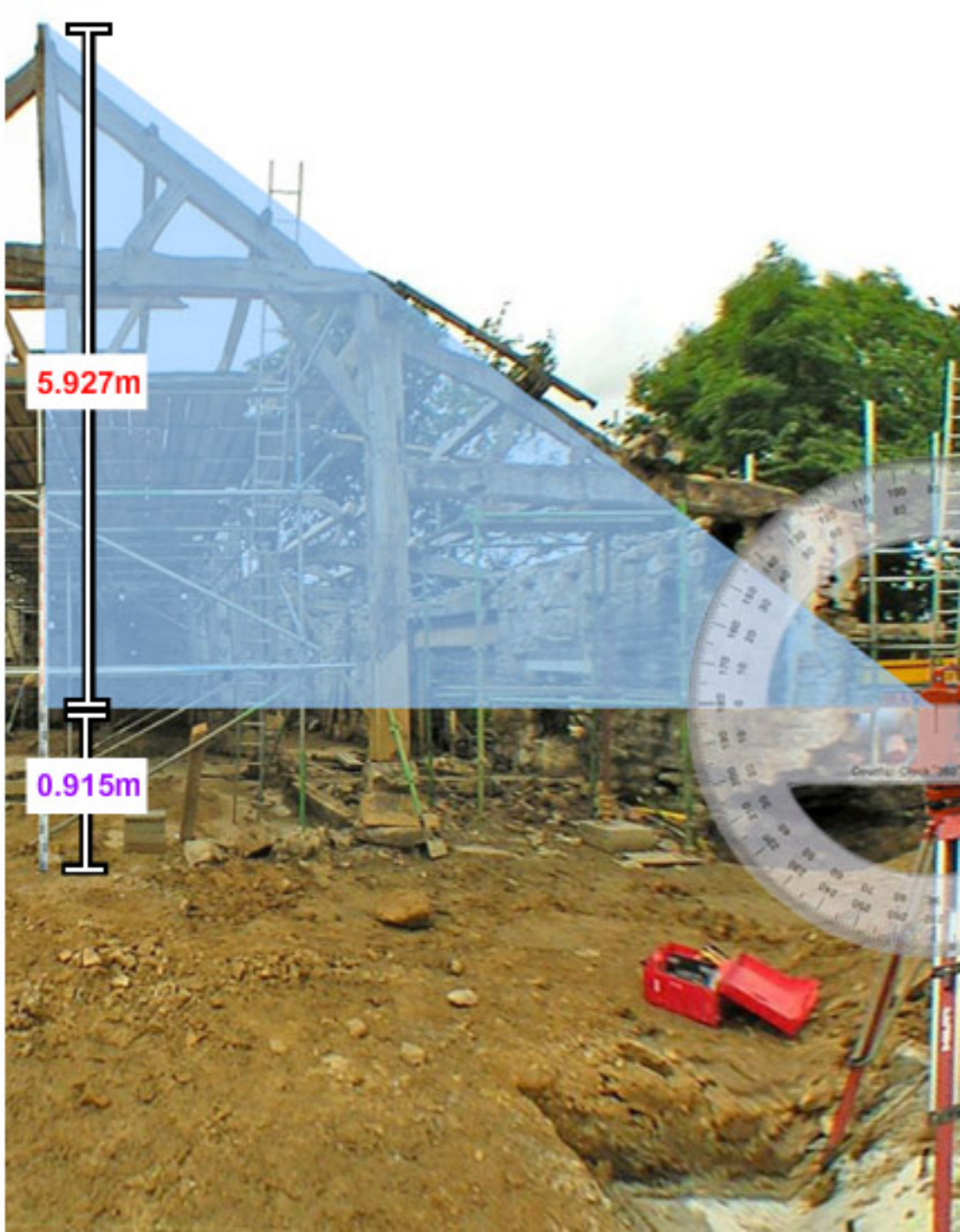
0.915m

Adding these two figures together will give us the **total height** of the building.

5.927m +
0.915m

6.842m Total height

Well done.
You have completed the exercise.



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ANSWERS

Q1: What is the staff reading?

Answer: 0.915m

Q2: What is the angle?

Answer: 36 degrees

Q3: What is opp to 3dp?

Answer: 5.927m