York explanation

Sunday, April 11, 2021 10:18 PM

The structural difference between the Nanjing and the York city wall that affects our model the most is that the York city wall's three sections all have different heights.
The diagram below shows a typical York city wall and it's cross-sectional area.

Figure 1 (left) and Figure 2

Variations of the York city walls (see diagram below).

Figure 3

Therefore, differently to the Nanjing City Wall, in York, we need to define all the heights as variables in python.

The number after "height" is the number counted from the left to right.

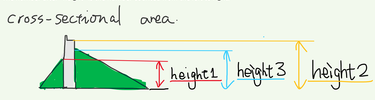


Figure 4

The following procedure for finding the Mass, Height of the Centre of Mass and initial GPE is exactly the same as the Nanjing City Wall, so it is not necessary to repeat the same explanation. Though there is one difference I need to mention, which is that the York City Wall's two outer sides (green in the diagram above) are triangles not trapezia, but we can still use the same algorithm because a triangle is just a trapezium with its top length zero.

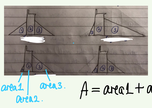
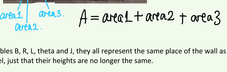


Figure.5



Variables B, R, L, theta and J, they all represent the same place of the wall as they were in the Nanjing model, just that their heights are no longer the same.

Figure 6

3 heights of the wall (each corresponds to the height of its section):

Figure 7

Note that the h1 is useless in this model, we do not need it.

Same as the definition we made in the Nanjing model, J is the area of the 45 degrees triangle formed by the collapsed wall.
J_h2 is that 45 degrees triangle J with height "height2".
J_h3 is that 45 degrees triangle J with height "height3".
The final height of the centre of mass is "fmY(final mean Y)".

Due to the lack of information I can access, I do not know what is underneath the ramparts, whether the stone part (middle section) is a rectangle (on the left of the diagram below) or a trapezium (right), and if so, the base of the trapezium.
Therefore, I cannot figure out what is the value of L.
I will just assume that the stone part is a rectangle, which is the left scenario on the diagram below.
However, I have left the algorithms for when L is known, so in future, if we get the L value, we can use it to improve the accuracy of this model.

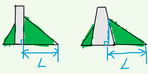


Figure 8

Obtain B and R:
B = (L x height3) / 2
R = A - B

calculate the cross-sectional area(triangles)---J_h2 and J_h3:

Figure 9

Similarly to the York City Wall, there are two possible scenarios when the Nanjing wall collapses:
(This depends on the length, height, structure of the wall).

Case 1:

The area of the 3rd triangle (see Figure 3) of the wall does NOT change, the height of the middle (2nd section) stone wall and the 3rd rampart section does NOT change.
Section 1 and part of the section 2 slides down to create a slope which inclines and angle of 45 degrees to the ground.

Figure 10

Case 2:

The area and height of the 3rd triangle (see Figure 13) of the wall does NOT change.
Section 1 and 2 slides down to create a slope which inclines and angle of 45 degrees to the ground.

Figure 11

Case 3:

All the sections change shapes, the 3rd section becomes smaller to fill the triangle J.

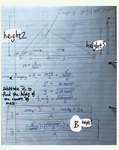
Figure 12

if R >= J_h2:
Case 1.

```
area_a = (height2**2)/2
*math.tan(math.pi/4)
area_b = R - area_a
area_c = B

fmy_a = height2/3
fmy_b = height2/2
fmy_c = height3/3
```

if J_h2 >= R > J_h3:
Case 2.



```
area_a = R
area_b = 0
area_c = B

fmy_a = (math.sqrt(2*R*math.tan(math.pi/4)))/3
fmy_b = 0
fmy_c = height3/3
```

R <= J_h3:
Case 3.