Hello IGN Code-Foo Organizers

This is my answer to:

The Avengers just made a surprise visit to San Francisco. How many legos would it take to rebuild the Golden Gate Bridge? Describe each step in your thought process.

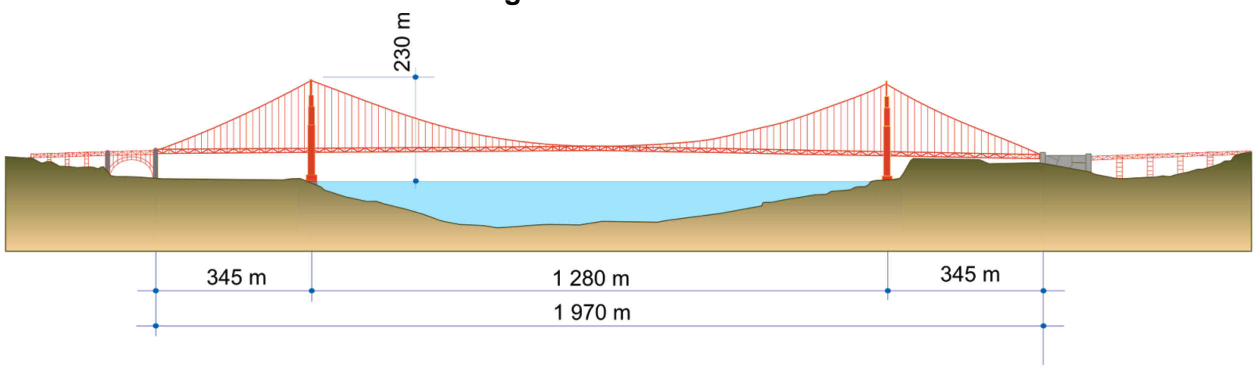
Short Answer: a TON of Lego bricks.

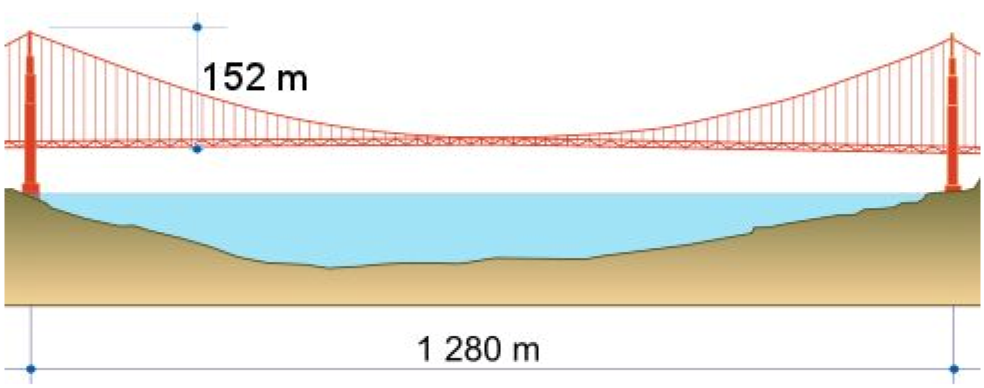
Long Answer: Well, here is my entire thought process:

Of course, we have to set sound ground rules. I need some rough dimensions for the Golden Gate Bridge and the dimensions for the Lego bricks. I have decided to use what one website I found deems to be the “classic” lego brick.

Here are the dimensions for both the bridge and Lego brick (Thank you Google!):

Dimensions of the Golden Gate Bridge:

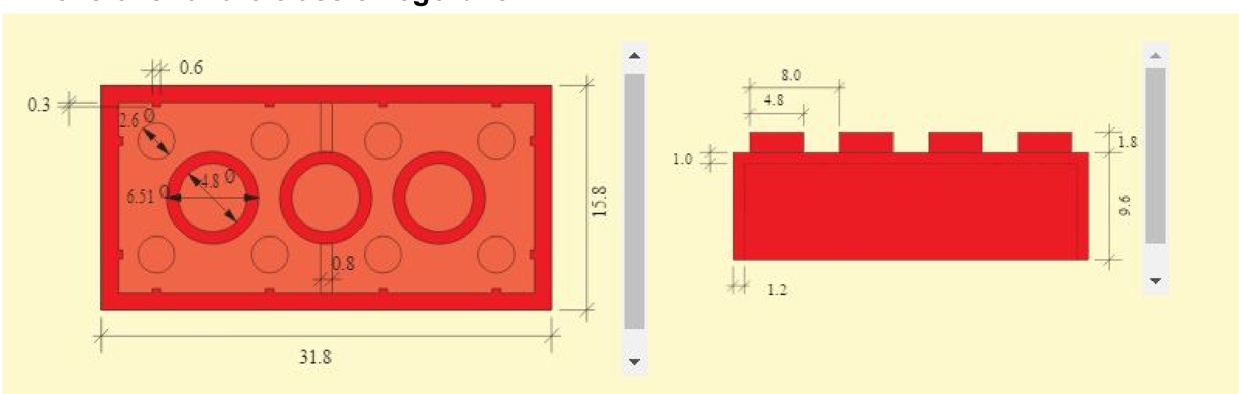




In addition: ~28 m width

Additional Picture of Golden Gate Bridge for eyeballing reference:

Dimensions for the classic Lego brick:



(Measurements in mm)
Therefore volume of a classic brick is: 31.8mm / 1000 * 15.8mm / 1000 * 9.6mm / 1000 = ~4.8×10^{-6} m^3

Additional assumption: I'm going to use the cars to eyeball the dimensions not obvious in the diagrams. Each car is 4m long.

Note: a LOT of eyeballing incoming (prepare yourself….)

Let's start with the pillars that are the foundation of the bridge. Its length and width seems to be around two car lengths (8m). The widening at the base will cancel out the slimming at the tip. So a simple volume volume calculation gets us 8m * 8m * 230m = 14720m^3. 4x that for each pillar you get **58880m^3.**

There are also 4 rectangular prisms connecting two pillars each (8 total). Each rectangular prism is about 8m high, 28m - 16 m = 12m wide (width of Golden Gate - width of each pillar), and about 6m in length. Volume of each rectangular prisms = 8m * 12m * 6m = 576m^3. Multiply by 8 gets us **4608m^3**.

Now let's get to the deck of the bridge. I can't really tell what the bridge looks like underneath, so I'm just make a HUGE assumption that the deck is just a gigantic rectangular prism. Definitely gonna get get some inaccuracies here. However, I'm going to guess that the base of the bridge is about 10 m high. So 10m * 28m * 1970m = **551600m^3**.

Alright now for the suspension cables. Taking each suspension cord as a cylinder with diameter .2m (estimate, of course), therefore the area dA would be pi * $(.1m)^2$ = .0314m^2. From a rough glance at the drawings, the middle portion (second Golden Gate Bridge picture) has 75 on each side. The outer curves of the suspension cable seems to combine into another one half elliptic curve. Therefore, 75 * 2 * 2 = 300 total suspension cables.

To fully calculate the suspension cables we will need to calculate the arc of the suspender. The suspender makes a half ellipse shape and using the dimensions provided we get the ellipse equation:

$$x^2/640m + (y - 152)^2/152m = 1$$

with the deck as the x-axis and the middle of the bridge as the y-axis

Since the ellipse has a length of 1280m, dividing the length by 60 gets 21.33m, meaning that each suspension cable is roughly 20m apart. To get the total height of all the suspension cable, we would iterate from x = -640 to 640 by increments of 20, plug each of the x into the formula, solve for y, then sum up all the y-values. There's no way I'm doing this without help, so after putting the formula into MATLAB, I get around 1.75×10^4 m. Multiply by 4 to get 7×10^4 m.

The volume of the suspension cable is therefore 7×10^4 m * .0314m^2 = **2198m^3**.

Lastly, we calculate the suspender themselves. The suspenders can be taken as a cylinder about 4 times as wide as the suspension cables so that means the radius is twice as large (.4m diameter). Therefore the dA for the suspenders are pi * $(.2m)^2$ = .1256m^2. Now we have to calculate arc length over ds, the infinitesimally small arc length of the suspender. We will have to find the arc length of half of the ellipse.

The arc length L of half of the ellipse can be calculated by L = ∫ds where ds is defined as:

$$ds = sqrt((dx/dt)^2 + (dy/dt)^2)dt$$

the magnitude of the change of x and y

Parametrically, our ellipse equation can divided into:

$$x = 640\cos t$$
$$y = 152\sin t$$

Taking the derivative of the equation with respect to t gets us:

$$dx/dt = -640\sin t$$
$$dy/dt = 152\sin t$$

Integrating from 0 to pi (thanks to MATLAB again) gets us about 1365m. Multiply that by 4 again (counting both sides of the bridge as well the outer suspenders) makes the total arc length = 5460m. 5460m * .1256m^2 = 685.776 m^3 ~ **686 m^3**.

Now we add up all the values:

The (very roughly) estimated volume of the Golden Gate Bridge = **686 m^3** + **2198m^3** + **551600m^3** + **4608m^3** + **58880m^3** = **617972m^3**

Now we divide that by the volume of a lego brick to get:

(617972m^3) / (4.8 x 10^{-6} m^3/brick) = 1.28 x 10^{11} Lego bricks to build the Golden Gate Bridge

Whew! All done! I hope you enjoyed my write-up. I wasn't sure what to expect, so I just went all out. It was really fun! Thanks for reading!

- Andrew Tang

P.S. I think my short answer was wrong. That amount of lego bricks would weigh waaaaay more than a ton.