THE MATH OF EARTHQUAKES

An earthquake is the violent shaking of the ground caused by seismic shifts underneath the earth. Earthquakes can be devastating if they are strong or if they cause tsunamis, gigantic waves that reach out of the water and can drown hundreds. The strength of an earthquake is measured on the Richter scale, which goes from one to ten. The higher the earthquake's position on the Richter scale, the more damage it has the potential to do.

You might know of earthquakes that have occurred in the past, including an earthquake that occurred in Japan and caused the meltdown of the nuclear power plant in Fukushima. The plant had been built to withstand an earthquake of 8.6, while the earthquake that hit it was a 9.0.

This poster will explain the math equations they use on the Richter Scale and how this relates to the earthquake that hit Japan.

The Equations

The Change of Magnitude Formula: $\Delta M = \log(\frac{M_1}{M_2})$

The Expanded Form: $\Delta M = \log M_2 - \log M_1$

$\frac{M_2}{M_1}=10^{\log_{10}\frac{M_2}{M_1}}= 10^{\log M_2 - \log M_1}=10^{M_2-M_1}$ is the equation we use to find the ratios of the two magnitudes (the one the nuclear power plant was built to withstand and the magnitude that actually hit the power plant)

In the case of Fukushima, $M_2 = 9.0$ as that was the magnitude of the earthquake that hit the power plant. M_1=8.6 as that was the magnitude the power plant had been built to withstand.

$9.0 - 8.6 = 0.4$
$10^{0.4} = 2.5$

This means that the earthquake that hit Fukushima had a magnitude 2.5 times stronger than what the power plant had been built to withstand.

To find the energy of an earthquake scientists use the formula $\log E$ (energy)=1.5M(magnitude)

To find the energy of the earthquake the power plant was designed to withhold, the equation would be represented as $\log E = (1.5)(8.6)$. To get rid of the log, you'd multiply each side by ten so the equation becomes $E = 10^{(1.5)^{(8.6)}}$. The same must be done for the magnitude of the earthquake that actually hit the earthquake, the final equation of which would be $10^{(1.5)^{(9.0)}}$

To compare these two energies we use the equation $\frac{E_1}{E_2}$

$$\frac{10^{1.5^{9.0}}}{10^{1.5^{8.6}}} = 10^{1.5^{0.4}} = 10^{1.76} = 14.997 = 15$$

This fifteen represents that the earthquake that hit Fukushima was 15 times more powerful than the power plant had been built to withstand.

Energy is by far more of a concern when building a power plant because magnitude is not nearly as large or significant a number as energy. Energy is the reason the ground shakes and the cause of the nuclear meltdowns and damage done to cities. Magnitude is just a way to measure that energy on a scale of ten. In our results, we found that the energy was 15 times more, while the magnitude was only 2.5 times more. The fifteen times more was what, eventually, did the serious damage to the Fukushima power plant.