AN INSTRUMENT FOR ANOTHER TIME SCALE

The Tectonic Harp, or Wegener Harp, is a giant musical instruments sharing properties with Aeolian Harps (windharps). It propose a way to bring to the auditive perception the very slow displacement of tectonic plates. The detection of the movements is made through the vibration of long strings or cables connecting two pairs of towers.

Each pair of towers is connected through a long, stretched steel cable. The two cables are identical in all respects. One pair of towers is entirely located on one side of a tectonic fault; the other one has one tower on each side, meaning that the cable crosses the fault. The two pairs of towers are placed so that the wind conditions are identical for both.

The Tectonic Harp produces sounds through two different mechanisms. The first one (aeolian mode) is the natural vibration of the cables caused by wind variations, which is exactly the way small aeolian harps do work. The second one is a mechanical device that plucks the two cables simultaneously at regular intervals, in the same way as a church bell.

After the Harp is installed, the two strings are tuned through a tensioning device so that they vibrate at the very same frequency. In aeolian mode, the fundamental note of the strings will hardly be heard : it is a characteristic of windharps to play mainly on harmonics. This has relatively few importance in this particular case, since the lowest tone for each string is located within the infrasound realm, and would be inaudible anyway. The sounds produced by the wind vary constantly, so the two strings may sing on different tones, even in similar conditions.

Excited tones produced by the plucking of the strings will show a different behaviour. On the beginning, the two strings will play exactly the same tone. However, after a certain time, which depends on the relative speed of the two plates, the lateral displacement of one side will increase the tension in the string that crossses the fault. According to the vibrating strings equation, this will introduce a very slight change in its vibration frequency. This change is too small to modify the note itself; but it will create a small difference between the harmonic spectrum of the two trings, which will at some point create acoustic beats that could become perfectly audible. The progressive decrease in the period of these beats will be a measure of the relative displacement of the two plates.

Considering the very slow speed of tectonic displacements, several monthes, if not several years, may be necessary before the first beats can be perceived. Once they become audible however, their rhythm will slowly but constantly accelerate.

Aeolian tones played by the two strings may theoretically produce other acoustic beats. They could greatly enhance the experience for the visitor, but the natural variation of windharps sounds, even with a constant wind, may partially or momentarily blur them, or even prevent them to happen at all. Prior experiments on smaller windharps should be made to study the possibility of their occurrence.

LOCATION

Considering the necessity for the two pairs of cables to be exposed in a similar way to the wind, transforming faults - those that move along each other in the horizontal plane - are the best ones for such an instrument. The optimal fault must also comply with several criteria. Speed is an important one : acoustic beats will appear sooner on faults with fast relative displacements. Fast-moving faults can be found on the oceanic floor, but they are unusable for obvious reasons. Among ground faults, the fastest measured speeds are found in Siberia, in the area of the Kamchatka peninsula, an extemely active tectonic area (the peninsula itself is hardly one million years old) where the relative displacement can reach 8 to 10 centimeters per year.

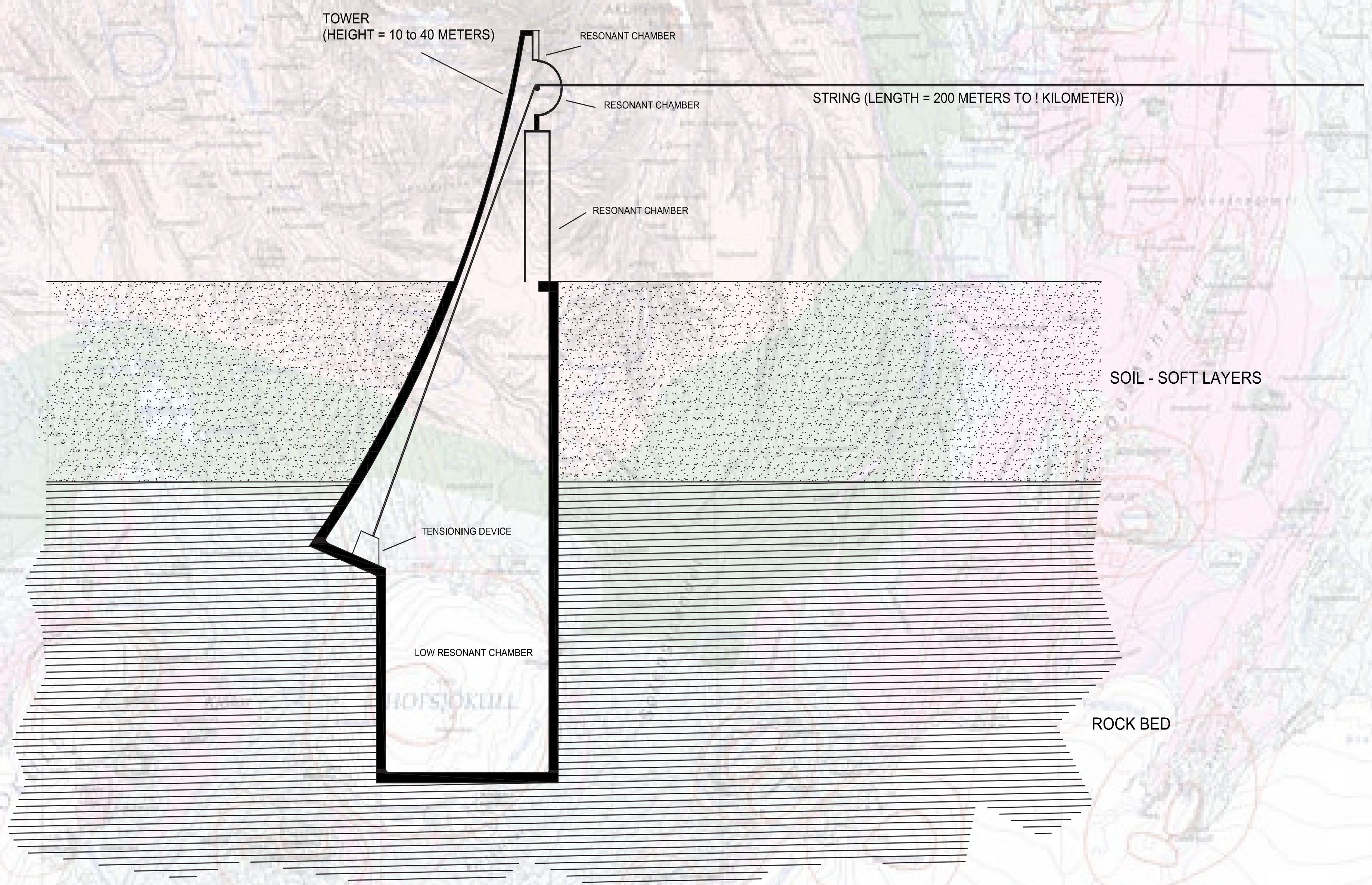
Other rapid faults exist in Turkey (North-Anatolia), Italia (Aquila area), Iceland (Thingvellir), California (San Andreas), New Zealand (Alpine), in the Afar territory at the Northern end of the great African Rift valley... which allows to introduce the criteria of accessibility. Some sites are not accessible because of political unrest, other because they are so far from major populated areas that the audience would be severely limited. The Thingvellir fault, which separates the North-American and the Eurasian plates, crosses Iceland. Through its width and accessibility, it appears as a good candidate. Moreover, secondary faults are fairly visible at the surface of the ground, and their limited width allows for isntrument of reasonable size. Their movement however is not very fast (3 to 4 centimeters per year). The San Andreas fault is certainly one of the most accessible, but its behaviour does not allow a valid determination of its speed : its average displacement is 35 m in 1000 years, which corresponds to 3,5 centimeters/year, but this movement is not smooth nor constant : it proceeds by sequences of long halts and brutal displacements, like the 1857 one during which a six-meters displacement occurred suddenly on a distance of more than 300 km. Several faults present a similar behaviour, and an exhaustive study should be made in order to determine the optimal location in that respect.

The last main criteria is the geology and soil composition of the site. The rock layer should not be too far form the surface, in order to allow a proper anchoring of the towers in the plates. Improper anchoring of the towers increases the risk of superficial ground movements which could interfere with the movement of the plates themselves.


THINGVELLIR | ICELAND


RIFT VALLEY | EAST AFRICA


SAN ANDREAS | CALIFORNIA



STRINGS AND TOWERS

In order not to be influenced by the surface movements of the soil, the towers should rest into foundations that reach the rock substrate. They should be anchored in the underground layers the same way as the stainless steel «nails» that are used to measure the displacement of the plates through GPS. measurements. This deep rooting will also allow the towers to resist the very strong tension that is necessary for the strings to become as horizontal as possible. Perfect horizontality is physically impossible - it would require an infinite tension. Limiting the deflection at the center can however give the almost perfect illusion of it, but it requires a tension of several hundreds of thousands of Newtons to be achieved, hence the necessity to build very strong supports.

The towers are made of concrete. They are equipped with a series of resonant chambers. Some of them - the cylindrical and spherical structures that appear above the ground - are made of stainless steel. The low frequency of the first harmonics, which corresponds to a long wavelength, requires larger resonant chambers. The main ones will be as deep as the foundations themselves. They will take most of the space inside the towers, and also include the hollow space left between the foundation walls; they will be shaped like elongated tubes. Their resonance modes will be similar to that of overdimensioned organ pipes.

TECTONIC HARP

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