

On the Duration of the Strongest Part of Motion in Destructive Earthquakes.

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The disturbance due to a large earthquake is, when observed by means of a sensitive seismograph, generally found to last several hours. The duration of the sensible part of the motion is of course much shorter. Still it may sometimes happen that at or near the epicentral district of a destructive earthquake, the ground is kept for a considerable time interval in a state of shaking, owing to an incessant occurrence of the after-shocks. Thus at the *Kushiro-zaki* light-house, on the occasion of the Hokkaido earthquake of March 22, 1894, at 7h 56m pm., the lamp could not be kept lighted for the 30 minutes after the great shock on account of the almost continual succession of the tremblings; the origin of disturbance being under the Pacific at a distance of about 100 km from the coast of Kushiro and Nemuro. For the sake of reference I give next the duration of the "principal portion" of the ordinary, or non-destructive, earthquake motion, obtained from the macro-seismograph observations at Miyako (province of Rikuchu), and Kyoto.

Miyako.....	Duration of Principal Portion, 0.7 sec. to 26 sec.
Kyoto	6.0 ,, ,, 20 ,,.

The duration of the principal portion, which according to the observations at Miyako and Kyoto varied between 0.7 and 26 sec.,

may be taken in ordinary cases to be from a few seconds to about half a minute. The movements are, however, not uniformly large throughout the principal portion of an earthquake. On the contrary, there are usually, in the seismic motion due to a near origin, a few prominent vibrations at the commencement of the principal portion which are much larger than the others. This particular feature of motion is specially well marked in strong and large earthquakes.

The following list gives the duration of the strongest part of the principal portion for the 19 destructive, semi-destructive, and severe earthquakes in Japan, measured with the Gray-Milne-Ewing type macro-seismographs at the different stations :—

No.	Date.	Earthquake.	Place of Observation.	Duration of the Strongest Part.
1	Oct. 15, 1884	Tokyo Eqke. (severe)	Tokyo	7.0 ^{sec.}
2	June 20, 1894	Tokyo Eqke. (semi-destructive)	"	4.3
3	Oct. 7, "	Tokyo Eqke. (severe)	"	4.6
4	Jan. 18, 1895	" "	"	8.0
5	Sept. 7, 1892	Mino-Owari Eqke. (semi-destructive)	Gifu	9.5
6	Jan. 10, 1894	" "	"	6.0
7	Sept. 7, 1893	{Kagoshima (Chiran) Eqke. (semi-destructive)	Kagoshima	6.0
8	Aug. 12, 1898	{Fukuoka (Itoshima) Eqke. (semi-destructive)	Fukuoka	8.5
9	Aug. 31, 1896 (at 4 ^h 20 ^m pm.)	Rikuchu-Ugo Eqke. (severe)	Miyako	4.0
10	June 7, 1903	Taito Eqke. (severe)	Taito	6.9
11	April 24, 1904	Kagi " (destructive)	Tainan	8.6
12	Nov. 6, "	" " (")	"	13.0
13	March 17, 1906	Great Kagi Eqke.	"	11.9
14	April 14, 1906	Kagi Eqke. (destructive)	"	13.9
15	Jan. 11, 1906	{Basshishyo and Bokusekikaku Eqke. (destructive)	"	19.6

No.	Date.	Earthquake.	Place of Observation.	Duration of the Strongest Part.
16	April 23, 1898	{ Origin off the NE coast of Main Island. (severe)	Miyako	19.0 ^{sec.}
17	March 7, 1899	{ Origin off the E. coast of Kii. (destructive)	Wakayama	19.0
18	Aug. 31, 1896	Great Riku-U Eqke.	Miyako	26.0
19	Oct. 28, 1891	Great Mino-Owari Eqke.	Tokyo	28.0

Of the above 19 earthquakes, the twelve severe, semi-destructive, and destructive shocks, namely, Nos. 1, 2, . . . 11, and 15, were not what may be called a great earthquake, namely, extensive and very destructive seismic disturbance. Again, the three Formosa earthquakes, Nos. 12, 13, and 14, were very destructive, having caused the following amount of damage :—

Eqke No. 12 : 45 lives lost, 490 houses entirely destroyed.

„ No. 13 : 1249 „ „ , 5669 „ „ „ .

„ No. 14 : 15 „ „ , 1540 „ „ „ .

These Formosa earthquakes were, however, each quite limited in area, indicating the relative smallness of their magnitudes. Now, in the cases of the 14 earthquakes, Nos. 1 to 14, the duration of the strongest part of motion lasted 4.0 to 13.9 sec., with the average value of 8.0 seconds; being in the majority of cases less than 10 seconds. Eqke No. 15 indicated the duration of 19.6 sec.

In the two earthquakes, Nos. 16 and 17, which were large submarine disturbances, the duration were each 19 sec. Finally, the Riku-U (No. 18) and Mino-Owari (No. 19) disturbances were very great destructive shocks, the duration of the strongest motion being 26 and 28 sec. respectively.

Summary. In destructive shocks, the duration of the strongest

part of motion is generally 4 to 10 seconds. When, however, the earthquake is very great, that is to say, extensive and violent, the duration in question may be nearly 30 seconds. These results will be of use in the consideration of the destructive effects of earthquake shocks on different structures.
