Ⅰ－B85 Relating N-value to Attenuation of Elastic Waves

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1. Introduction

The response of a structure to an earthquake ground motion is strongly affected by ground motion characteristics. Therefore, it is of an importance for earthquake-resistant design of structures to determine these characteristics. The ground motion characteristics is largely influenced by surface geology. It is recognized that seismic coda waves represent the surface geology conditions. Studying of coda wave is one of keys to understand the surface geology conditions which very much affect the ground motion. Consequently, coda waves have been worth to be intensively studied.

2. Sompi method

In this study, SOMPI method, a relatively new technique for spectral analysis, is adopted in consideration of the method's advantage. SOMPI method can obtain frequencies, growth rates (quality factor) and amplitudes of frequencies. Applying SOMPI method to coda waves, the surface geology conditions are evaluated in terms of amplitude spectrum. The spectrum provides quite good agreement with that by Fourier method. In addition, another and bigger advantage is that the method can provide us with wave attenuation property, quality factor, of the ground.

3. N-value of the ground

A method is proposed in this study which applies SOMPI method to coda waves. This method associates averaged quality factor with N value, averaged up to the depth of 10m. The relation shows that the distance from epicenter to seismic station does not distort the relation between the averaged quality factors and averaged N value. The method succeeds in linking quality factors directly extracted from accelerogram with N value representing site geology conditions.

Most of conventional ways to study the characteristics of the surface geology use data of the soil density and/or the velocity distribution in depth. In Japan, in many cases, N-values are used, too. However, up to now, the N-values have been difficult to relate to other physical parameters, although the values might show the softness of the ground.

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4. Data analyzed

In this study, accelerograms from the Western Kagoshima Earthquake with 6.5 magnitude of 26 March, 1997, were analyzed. These accelerograms were recorded by the K-net strong motion observation network that NIED has deployed over the Japan islands after the Kobe Earthquake of 1995. The Western Kagoshima Earthquake of March is one of the largest earthquakes in and around Japan islands since the Kobe Earthquake. At some number of stations close to its epicenter, PGA exceeded 500 gals.

5. Coda-wave

Coda wave shows the characteristics of surface layer conditions beneath a seismic station. For this reason, coda wave is employed as the research subject.

There has been no decisive definition of coda wave up to now. Coda wave is defined, in this study, as the part of the accelerograms after peak ground acceleration (PGA) to the end of record, so that PGA of coda wave does not exceed a certain percent of PGA of the whole accelerograms. For engineering purpose, 10 percent PGA is accepted as threshold. The figures shown below give coda waves with 10 percent PGA of that of whole accelerograms.

The representative quality factor and the dependency of distribution of quality factors on frequency

K-net station code	Representative *Q**	Dependency on *f***	Averaged N value***	Distance (km)
KGS001	22.87~38.97	0.812~1.091	17.7	29.82
KGS002	21.92~26.63	0.690~0.831	63.5	10.61
KGS003	31.60~50.97	0.638~1.318	15.0	18.83
KGS004	9.99~26.70	0.703~1.363	4.7	19.39
KGS005	33.49~34.98	0.594~0.715	68.0	12.51
KGS006	11.02~16.89	0.819~1.206	16.3	30.73
KGS007	11.31~33.77	0.565~0.635	8.8	22.88
KGS008	14.18~25.90	0.732~1.463	27.5	31.42
KGS009	10.29~16.77	0.755~0.986	7.1	45.42
KGS010	16.67~28.32	0.909~1.075	15.2	34.48
KGS011	24.96~66.10	0.788~1.193	16.7	46.31
KGS016	30.10~64.42	0.547~0.829	18.1	65.77
KGS036	8.88~13.66	0.611~1.694	6.2	53.44

* *the representative quality factor,* ** *the dependency of the distribution of quality factors on frequency*

*** *the averaged N value up to the depth of 10 m.*

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