STUDY ON THE CHARACTERISTICS AND INFLUENCE FACTORS OF RESPONSE SPECTRUM IN BLASTING VIBRATION

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ABSTRACT

The influence factors and the general research situation of blasting vibration to structures are elucidated briefly. The blasting vibration was monitored on site. Using the data from the monitoring of blasting ground vibration, the response spectrum of velocity, acceleration and displacement are fitted out. These spectrum are analyzed and compared. Influence of the ground parameters such as the clay or inclusion liquefaction interlayer on response spectrum are discussed. The displacement spectrum, the velocity spectrum and the acceleration spectrum can be used as design criteria in the dynamic response analysis of the structures. The method provides an effective tool for studying blast seismic effect, specially, for constituting velocity-frequency criteria.

Keywords: blasting vibration; site response; response spectrum, liquefaction

INTRODUCTION

The vibration wave produced by blasting may have different effect on underground constructions and buildings, even damage them. Since primitive damage exists in rock and constructing materials, when a dynamic load on these weak interfaces and reach to enough strength, faults will move and enlarge, and at last the weak position brake. The main damages by blasting are: Base liquefaction and sinks; Constructions breakage caused by vibration acceleration (primary horizontal inertia force). Under the blasting seismic wave, there are tow special vibrating forms: 1) Top horizontal moving vibration, 2) Construction elements (such as wall, floor) flexibility vibration. The vibration prediction and its corresponding standard have been an important step in blasting engineering.

A true and objective evaluation is so necessary that it can remove people’s misgivings, and it is related to the blasting work’s success and economic benefits. To study the effect of vibration on constructions, the authors and their colleagues monitored and research a lot of engineering examples and gained a great deal of valuable data[1-4].

This paper discussed the blasting seismic spectrum character and its influence through the data gained in Quanzhou by a FEM (Finite Element Method code named NDFEPS-2D)[5].

1 BLASTING MONITORING

Rock in Qingmeng Developing District Plaza is little and middle-degree weathered grey and light red granite, blocky and hard. The blasting site is complicated: Detai Road at east and the nearest distance
is 11 M, and the distance to Jianlian Building and Huajia Building are 52.7 M; Chonghui Road at north and the distance between an office and working site is 22 M.

An IDTS3850 blasting vibration analysis system was used (max sampling rate 50k Hz) to monitor the blasting process. Sensors is CDJ21 type, whose frequency scale is 2 ~500Hz, and it can transform velocity to acceleration or vice versa. For the length reason, monitoring data will be discussed in another paper.

2 INTRODUCTION ON THE DYNAMIC ANALYSIS CODE (NDFEPS-2D)

NDFEPS-2D, that we created, can 1) get the whole ground acceleration process; 2) made an estimation on liquefaction by real time monitoring of elements’ hole pressure; 3) Different parameter value to evaluate the influence on the ground, et al.

A plane 4-node element is adopted in NDFEPS-2D dynamic code to complete the grid of the soil section. The computation has treated the site as half-extending body, and the plane strain mechanic principle was applied to get the dynamic response. The seismic acceleration load was made on the bottom nodes. Linear acceleration integrate method was used in the response fit to gain the acceleration response spectrum, velocity response spectrum and displacement response spectrum.

3 CURE AND DISCUSSION ON ACCELERATION, VELOCITY AND DISPLACEMENT RESPONSE SPECTRUM

The blasting condition and monitoring parameters is shown in table 1. Choose a typical velocity Time-Distance curve (site 1 to 3, shown in Fig.1 and table 2) and made the frequency and response spectrum. The frequency response is shown in Fig.2, and the response spectrum is shown in Fig.3.

<table>
<thead>
<tr>
<th>Blasting parameter Minisecond No.</th>
<th>Hole No. (per)</th>
<th>Max. charge per hole (kg)</th>
<th>General charge (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>62</td>
<td>120</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>92</td>
<td>262</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>82</td>
<td>246</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>46</td>
<td>126</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>34</td>
<td>62</td>
</tr>
</tbody>
</table>

Table 1 blasting condition in monitoring sites

![Fig.1 Typical velocity Time-Distance curves (level direction 2)](image-url)

Table 2 Typical monitoring data of peak particle velocity (PPV)

<table>
<thead>
<tr>
<th>No</th>
<th>distance (m)</th>
<th>Q (kg)</th>
<th>PPV vertical (cm/s)</th>
<th>Main frequency( Hz)</th>
<th>PPV Horizontal X (cm/s)</th>
<th>Main frequency( Hz)</th>
<th>PPV Horizontal Y (cm/s)</th>
<th>Main frequency( Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>103</td>
<td>262</td>
<td>2.5204</td>
<td>65.9180</td>
<td>0.9920</td>
<td>57.3730</td>
<td>1.0483</td>
<td>24.4141</td>
</tr>
<tr>
<td>2</td>
<td>121.2</td>
<td>262</td>
<td>1.8996</td>
<td>56.1523</td>
<td>1.4114</td>
<td>7.3242</td>
<td>1.2087</td>
<td>21.9727</td>
</tr>
<tr>
<td>3</td>
<td>153.5</td>
<td>262</td>
<td>1.4026</td>
<td>34.1797</td>
<td>0.9586</td>
<td>36.6211</td>
<td>0.5359</td>
<td>34.1797</td>
</tr>
</tbody>
</table>
From the figure 3, when the biggest charge quantity was equal, the variety regulation of the acceleration, velocity and displacement response spectrum curves was almost consistent in the different monitor position. And with the distance increment to the charge, the value of the acceleration, velocity and displacement response spectrum curves was reduced. It expressed to blasting vibration wave while spreading from the near to the distant to diminish the response spectrum value accordingly.

From Fig.3, with the distance increment to the charge, the periods of velocity response spectrum increase (frequency decreases). It suggests that although during the propagation the vibration is weaker and weaker, but the vibration dominating frequency has the direction to low frequency. This can explain why the nearer constructions demolished while farther ones intact.

From the figure 3(a) can see, the acceleration response spectrum enlarges with the increment of the distance within the scope of short period. But within the scope of longer period, it is decreased. Increase and reduce the boundary of earthquake period long or short is in 0.15 sec. It expresses blasting vibration wave to the short period structure to produce bigger force.

From the Fig. 2(b), figure 2(c), with the distance increment to the charge, the peak value of velocity and displacement response spectrum is diminished. But for same measure a point to say, along with the aggrandizement of period, the peak value of velocity and displacement response spectrum increase gradually.

From Fig.2 and Fig.3, with the distance increment to the charge, the periods of velocity response spectrum increase (frequency decreases). It suggests that although during the propagation the vibration is weaker and weaker, but the vibration dominating frequency has the direction to low frequency. This can explain why the nearer constructions demolished while farther ones intact.

4 THE INFLUENCE ANALYSIS ON THE RESPONSE SPECTRUM IN THE LIQUEFACTION

The blasting vibration wave looks like as importation wave in bedrock. The earthquake signals (site 2, Fig.1 (b)) had been processed by NDFEPS-2D code. This paper discusses two kinds of circumstances: the clay ground and inclusion liquefaction interlayer ground. The acceleration, velocity and displacement response spectrum were shown in Fig.4.
From the Fig.3, we can see:

- The clay or the inclusion liquefaction interlayer has already reduced the function of the earthquake in short period parts, but to long the period part contain fortified function. Increase and reduce the boundary of earthquake period is near 0.1 sec. The influence layer of existence can cause the acceleration value of short period parts of the earthquake reduced. Long period part of the earthquake make it to be increased but enlarge of the effect isn't very obvious.

- The velocity value of the short period earthquake is reduced when the ground contains liquefaction interlayer. And it of the long period increased. Increase and reduce the boundary of earthquake period is near 3.5 sec. The velocity value is increased very soon when the earthquake frequency is in 0-1.2 sec. in the clay ground. It is reduced very soon when the earthquake frequency is in 1.2-4 sec. The velocity value is increased slowly with the increment of the earthquake period in inclusion liquefaction interlayer ground.

- The displacement response spectrum and the velocity response spectrum are basically consistent in inclusion liquefaction interlayer ground. But increase and reduce the boundary of earthquake period is near 1.0 sec. The displacement value is increased very soon when the earthquake frequency is in 0-0.6 sec. in the clay ground. It is reduced very soon when the earthquake frequency is in 0.6-1.0 sec. The displacement value is increased with the increment of the earthquake period in inclusion liquefaction interlayer ground.

5 CONCLUSIONS

By the analysis of blasting vibration, working out the effect of inclusion liquefaction interlayer ground on the response spectrum. And it is summarized the blasting vibration law in the propagation with different ground, which can be helpful in future to make a reasonable vibration-frequency standard.

REFERENCES

