

Research on common seismic wave source

Xu Fang Zhu^{1, a}, Bing Yan^{2, b}, Lan Luo^{3, c}

¹ College of electronic Eng., Naval Univ. of Engineering, Wuhan, China

² Dept. of Weaponry Eng., Naval Univ. of Engineering, Wuhan, China

³ Naval Armament Academy, Beijing, China

^a1580284687@qq.com

Keywords: seismic wave; seismic source; method stimulate technology

Abstract. The technology of seismic wave is more and more useful in mineral prospecting, buried targets exploring and some other items. There are many disadvantages in the traditional seismic wave stimulate technology. This article summarises and compares the advantages and disadvantages among the seismic wave. Then the related stimulate model is built to obtain better stimulate effect.

Introduction

In order to obtain the seismic record as much as possible not be disturbed, a reasonable choice of excitation and reception conditions are very important. There are two types of artificial source, explosive and non-explosive source. Since its own seismic exploration, explosive source has been in a dominant position, because other methods are difficult to obtain a high energy density generated by the explosion. In recent years, the use of non-explosive source world trend of rapid strengthening, which is closely related to the rapid development of increasingly complex conditions and exploration and exploration equipment, technology, following the introduction of several commonly used source accordingly.

Common seismic wave source

(1) Explosive source

Explosives are detonated by a detonator explosion from the input current to explosives, time is very short, up to 2ms. In detonator cord is disconnected as the explosion timing signal that the seismic waves have been excited begun to spread^[1]. Amount of explosives the number, the explosion of rock media, coupled with the explosion of media kits and shape factors have an important influence on the shape of seismic waves, wave amplitude, frequency and other characteristics. Experience has shown that the excitation of seismic wave attenuation explosion soon pseudo-sinusoidal pulse with the leading edge of a very steep, energy is highly concentrated. Expanded form symmetrical vibration center explosion in a homogeneous medium, mainly produce longitudinal waves.

The results showed that the amount of explosives affect seismic pulse characteristics. Suppose a spherical explosive quantity of explosives is Q , the seismic pulse duration t is the relationship between the dose:

$$t \propto Q^{\frac{1}{3}} \quad (1)$$

A pulse amplitude and explosives quantity Q in relation to obey the following formula:

$$A \propto Q^{k_1} \quad (2)$$

Where k_1 is a variable factor. When a small amount of explosives, k_1 up to 1-1.5; when large amounts of explosives, k_1 can be reduced to 0.5-0.2. This is due to a small amount of explosives, destructive effects of rock is small, most of the energy is converted into elastic wave explosion; when the explosive increases, most of the energy damage to the surrounding rock failure, assigned to the elastic wave energy subtraction small. Vibration amplitude relationship between the amount of explosives with different geological conditions vary, the actual work to be determined by the test.

The explosion in the sea, k1 average of 0.65.

Depending on the relationship between frequency and period or amount of explosives seismic pulses is:

$$T^* = \frac{1}{f^*} \propto Q^{k_2} \quad (3)$$

Visible dose, the greater the visual cycle wave, the lower the frequency.

Explosives shape also affect the characteristics of the excited vibration. Generally spherical explosives best; the effect of long cylindrical explosives worse, tend to produce stronger horizontal transmission interference. In order to make the explosion energy is concentrated under increasing excitation energy transfer of seismic waves, but also to facilitate the construction, people developed shaped shells, earth rockets, explosions and other cable molding explosives. This greatly improves the effectiveness of excitation of seismic waves. In order to increase the effective energy, sometimes using a combination of the working methods of the explosion, that is a big bag of explosives into several small explosives exploded simultaneously. The disadvantage of dynamite source: the difference between the degree of automation, manual big risk; difficult to guarantee quality, such as excitation control points are all excited to grasp the depth of bottlenecks, poor reproducibility; contrary to the concept of environmental protection, explosive response to water pollution, harmful to aquatic organisms.

(2)Falling weight method or mechanical percussion source

Falling weight method or mechanical shock hypocenter [2] is one of the oldest non-explosive source. The easiest falling weight method is the use of the source or mechanical shock a few pounds heavier hammer or other heavy object hit the ground as the source. Due to weak energy from the excited seismic wave propagation far, currently only used in seismic exploration project. Modern oil seismic exploration with falling weight method is to several tons heavy objects from a height of about 2-3 meters down to the ground, hit the ground excite seismic waves. Weight is generally the weight that a few tons heavy big iron, with a chain hanging in a special vehicle crane, if necessary impact to fall from a height.

Restricted gravitational freefall speed, the energy is not big enough. Later, the emergence of new strike source, make weight for greater terminal velocity; meanwhile, hit the ground to produce a sharper pulse spectrum dynamite source close to the pulse spectrum generated. For example, compressed air driven piston or the drive plate and the hammer hits the ground source within the cylinder. Its impact velocity is greater than the average speed of the falling weight method many times.

The biggest drawback of this type of source is the horizontal direction will have serious interference noise.

(3)vibroiseis (continuous vibration source)

Vibrator produces a duration from a few seconds to tens of seconds, sinusoidal oscillation frequency changes over time, so called continuous vibration source. Because of the vibration frequency and duration of it can be produced in advance and change control, also called vibrator. It produces controllable functional form for Sasser:

$$g(t) = A(t)\sin(w_1 t \pm \frac{bt^2}{2}) \quad 0 \leq t \leq T$$

$$b = \frac{w_2 - w_1}{T};$$

Where: A (t) is a slowly varying amplitude envelope function:

w_1 is scanning start angular frequency; w_2 is the angular frequency scanning is complete; T is the scanning duration.

The frequency of changes in the way the signal in two ways:

One is the frequency from low to high, is called upscaling scanning, corresponds to the positive

numbers. One is the frequency from high to low, called the reduced frequency scanning, corresponding to the above formula minus sign. T is generally 3-40s, a lot more than conventional seismic signal length, the duration of the scan signal enhancement is to strengthen the next wave propagation energy.

Vibrator applied force on the ground is generally 15t, plus car load of up to 17t or 20t. Nevertheless, this force is smaller. In order to enhance energy and suppress interference echoes, probably take a combination of excitation: with several source at the same time not far away from vibration and each vibration source at one point several times to dozens of times, take a few minutes to the total time of vibration tens of minutes, and finally get a spot superimposed excitation energy field record.

Vibroseis has many advantages, the first is to control the frequency of seismic wave propagation to meet the needs of exploration, take advantage of the energy source. Second, compared with dynamite and pneumatic source, its consumption is low. Finally, it can work in the city, you can not drill, but also does not damage the environment. Therefore, it vibroseis gradually has been widely used in seismic exploration

(4)Knock gas source and pneumatic source.

Seismic wave generator gas detonation source is a closed cylindrical explosion chamber, which can be freely retractable floor, direct contact with the ground, the top of a heavy recoil body. The mixed gas (propane and oxygen) into the explosion chamber, with an electric spark explodes, driving the explosion chamber activities excite seismic waves hit the ground floor. Usually with three or more pneumatic devices simultaneously firing, detonation signals transmitted by radio by the recording device. This source is similar to hammering source, mostly installed in the car for land exploration. It is rich in low-frequency pulse generated, and therefore have a greater penetration.

Non-explosive source of ocean exploration is the most widely used air guns. It belongs to the pneumatic source, namely the explosion to release high pressure gas, the mixed gas to air, air gun source is a typical pulse source, the fourth chapter will detail the principle source of air guns and shooting techniques.

(5)Sparker source

Rivers and lakes in the shallow water or river seismic exploration common is sparker. It is inspired by a spark generator of seismic waves through sudden water discharge current between electrodes. The main components of the sparker by boat entrainment of water into the electrode group, the capacitor bank can ship it with the charging from the generator through a specially designed switch connected to the system. First, the capacitor bank is charged by the generator, the excitation of the moment, this specially designed switching system connected to the current sudden, so capacitor banks gap between the electrodes through the brine discharge. Heat generated by the discharge is very high, so that the water is vaporized to produce a sudden rapid expansion of the vapor bubbles; discharge then quickly cooled, the vapor pressure of the bubbles burst and the excitation pulse, the combined total of the vibration. The source is characterized by high seismic wave frequency excitation (typically 100-1000Hz or more), and thus a higher resolution. Lower energy spark source available, so many use a combination of excitation.

(6)Speakers source

Speaker source is a non-contact acoustic emission system, the function signal generator, power amplifier and speakers and other components. Its working principle is: the low-frequency sine wave signal generator signal after amplification is supplied to the amplifier speaker, so the speaker can output high-frequency low-energy stable signal.

1) Signal Generator

Signal generator serves as a role source, the output signal quality is good or bad, directly

determines the system can achieve the desired design goals. To meet the system's accuracy requirements, and require subsequent matching device, the signal generator should be able to output high-precision low-frequency sine wave signal, and the output signal amplitude should be stable and should not have significant ups and downs.

2) Power Amplifier

PA is in a certain range of distortion, which can produce a maximum power output to drive a load of the amplifier. In general civilian usually hosts the rated output power not competent to drive the entire audio system, this time on the need to use the power amplifier. It is the weak signal from the audio amplifier or preamp, pushing sound generating device. In consideration of power, impedance, distortion, dynamic and different scope and control and regulation functions, different on the internal amplifier signal processing, circuit design and production processes vary. Amplifier frequency response characteristics should good, its frequency response range should be greater than the frequency response range of speakers, especially its response to the lower frequency limit should be less than the lower limit of the frequency response of the speakers. In addition, the selected harmonic amplifier distortion, intermodulation distortion should be as small as possible, a higher signal to noise ratio and dynamic characteristics to be excellent and the like.

3) Speakers

Speaker is a spectrum of the electrical signal into sound spectrum of the signal transducer. The role of the horn is to the current signal into the acoustic signal. Because sound - seismic coupling partial response characteristic, the angle of incidence is not too critical issue, but to the ground most of the sound wave energy is reflected or scattered, the coupling efficiency is very low, so choosing the right angle of incidence to a certain extent can improve energy coupling efficiency [3], in order to ensure repeatability, generally select the speaker axis perpendicular to the ground, namely sound waves emitted perpendicular to the ground. Sound waves emitted by the tone that the sine sound wave, sweep range generally between 30-100Hz.

Conclusion

This paper summarizes and compares the advantages and disadvantages of various seismic wave excitation technique, the actual application can select the appropriate source technology needed in order to get a good excitation effect in practice.

References

- [1] Yao Yao seismic wave field and seismic exploration [M]. Geological Publishing House, 2006 edition.
- [2] Xiong Zhang Qiang, Zhouzhu Sheng, Zhang Zhou seismic exploration equipment Principles and Applications [M]. Petroleum Industry Press, 2009 edition.
- [3] The seismic exploration [M]. Changsha: Central South University Press, 2010 edition.