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Abstract

When a combat helicopter fires, a high temperature and high speed air current is produced. It affects the helicopter's fuselage, horizontal tail, side-vertical tail and operating stability. This paper, using a lot of actual testing data, mainly introduces the measurement of the blast wave and jet stream caused by the weapons firing, and analyzes its signal features and its effects on the helicopter.

1.Introduction

The weapons equipped on the combat helicopter concern not only the helicopter's attacking ability but also its survival ability. From the weapons angle, the more kinds of weapons the combat helicopter equips with, the higher attacking ability and the better protective action for the ground force it has.The weapons equipped on the combat helicopter produce a transient high temperature and high speed air-current when they fire. The air-current will have some different effects on the helicopter's fuselage, horizontal tail,side-vertical tail and operating stability. The intensity of the air-current is great different in degree for the different kinds of weapons. There is a compatible problem when a combat helicopter is equipped with these different kinds of weapons(aero-cannon,rocket,missile). How to make them compatible perfectly is what we most concern about.Obviously, the high temperature and high speed air-current caused by the weapons fire is the crux of affecting the helicopter's weapon system. To understand the transient aerodynamic load which is mainly produced by the blast wave and the jet stream and its effects on the combat helicopter is difficult.Since there are a lot of factors, such as the transience and discreteness of the aerodynamic load,the different amount of the gunpowder in the weapons, the variation of the environment around, etc.,to make it complicated,the accurate calculation based on the theory is almost impossible althongh many restrictive conditions have been considered. So the better way to solve this problem may be the test. In testing, the pressure and its wave-form caused by the blast wave and the jet stream which appear on some parts of the helicopter can be captured and the load spectrum of the helicopter can also be got.

2.The signal character and the equipment of the testing

By analysizing the previous test data of these different kinds of weapons firing, we can see that the setup and the action procedure of the air-current pressure is very short. It's about tens ms. The action history can be divided into two phases; the first is the blast wave action, the second is the jet stream action.The character of the blast pressure is the transient action,the steep wave-form,the only 4~5 us rising time and the varied peak value which varies from tens to hundrands KPa depending on the relative

position of the weapons firing centre.Compared with the blast pressure,the jet stream has the longer action time and the less steep wave-form. It is clear that a measuring system suitable for the measurement of the blast pressure must meet the measurement of the jet stream pressure.As mentioned above, the distribution of the signal peak value is wide and the signal wave-form is quite complicated.Thus the bandwidth of the measureing system should be at least 300 KHz. The general transducer and analoque recorders would not reach such bandwidth.In test, we adopted a miniature piezoresistive pressure transducer and a transcent digital recorder (TDR). This kind of transducer uses a thin si-diaphragm as the sensor.Its external diameter is 4 mm. It has a very wide bandwidth and a very high response. It can satisfy the measuring requirement perfectly.The TDR is one of the ideal instrument for recording. Its analog-digilal coverter is fast. Its memory is quite large and it also has a very wide bandwidth.In addition,its sampling rate can be changed according to the time set. Thus the blast and the jet stream pressure can use the different sampling rate to sample. Connectted with a computer,the data acquisition, processing and storage is very quick and convenient.

3.The block-diagram of the testing principle

The measuring system consists of the pressure transducer, amplifier, TDR and the computer. The key instruments are the TDR and the computer. Fig. 1 shows the block-diagram of the testing principle.

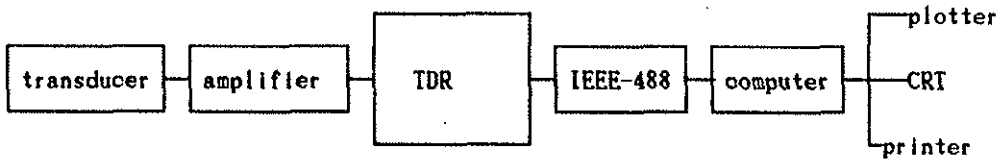

Fig.1

Sensed a pressure, the miniature pressure transducer outputs a voltage to the ampilifier, then to the TDR. The amplifire should be adjusted properly so that its output level is suited to the TDR. The TDR whose trigger level and sampling rate have been preset is connected to the computer. By the computer, the testing data can be processed on line.
A suitable sampling rate is important in test. We should take both the length of the signal recorded and the capacity of the TDR into account. Otherwise, the contradiction between the sampling rate and the recording length would result in the incomplete or the loss of the recording signal. In order to increase the accuracy of the testing, the sampling rate ought to be in accord with the bandwidth of the TDR. It is reasonable from the previous experience that the bandwidth is set between 250~400 KHz and the sampling rate for the blast pressure is set between 300~1000 KHz and for the jet stream pressure is set between 60~100 KHz.

4.The calibration of the pressure transducer

The calibration of the pressure transducer is done with the testing system

.A static unit calibration is adopted. From the calibration,an equation of the pressure acting on the transducer and the voltage outputing from the testing system can be obtained. Besides the static calibration, we use a shock wave tube to check the dynamic characteristic of the transducer before every testing. To check the dynamic characteristic of the transducer is necessary because some transducers may be fail-passive after used for several times.Fig.2 and Fig.3 are the dynamic characteristic curves of the transducers. The Fig. 2 shows that the transducer is qualified for the testing, but the Fig.3 shows that the transducer has over shooting phenomenon and it means that the transducer is not suited for a dynamic measure-ment because its output signal may be distorted.

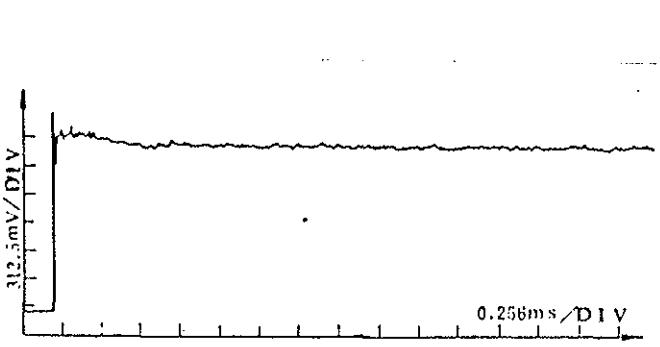

Fig.2

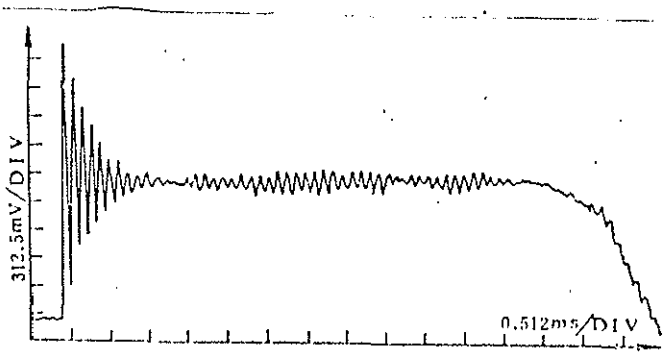

Fig.3

5.The result of the testing

In the firing test of these different kind of weapons(aero-cannon,rocket, missile),we used the testing system mentioned above to make more than ten times measurement under the different enviroments. A large number of testing data and curves were obtained. Having processed and analyzied these testing data, we can get the accurate pressure values caused by the blast wave and the jet stream when the different kinds of weapons firing and find the effects of the transient aerodynamic load on the helicopter.So,a reliable basis is provided for studying the compatibility of the helicopter and the weapons. Some typical P(t) curves corresponded to the different kinds of weapons firing are showed as below. Fig.4 is an actual testing curve when xx aero-cannon firing. The actual testing curves in Fig.5 and Fig.6 correspond to the missile and rocket firing respectively. Fig.7 is an actual testing curve of the attitude angle θ of the helicopter when the weapons firing. According to the result of the test, the effects of the aerodynamic load caused by the weapons firing on the combat helicopter is nearly clear. When the weapons firing, the peak value of the blast pressure greatly affects the structural strength of some parts of the helicopter. The destructiveness action, however, is made by the negative pressure appeared after the blast wave acting.For the jet stream, its disordered flam has a influence on the helicopter's cover and engine inlet, and the effect on oprating stability is mainly from the blast wave and receiling force causeed by the weapons firing.

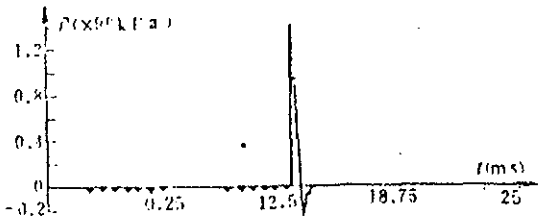

Fig.4

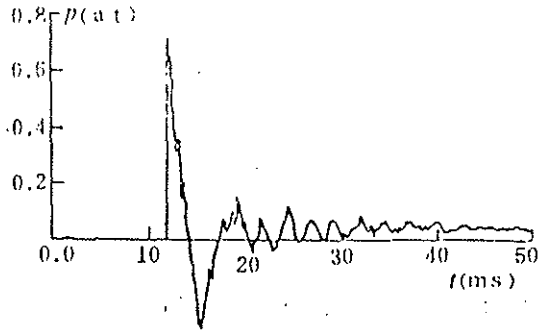

Fig.5

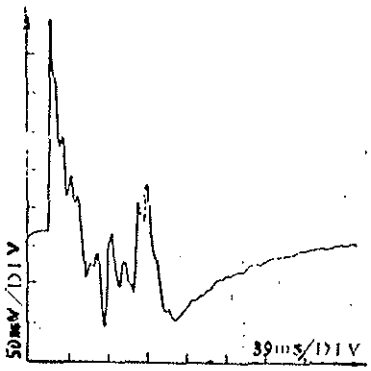

Fig.6

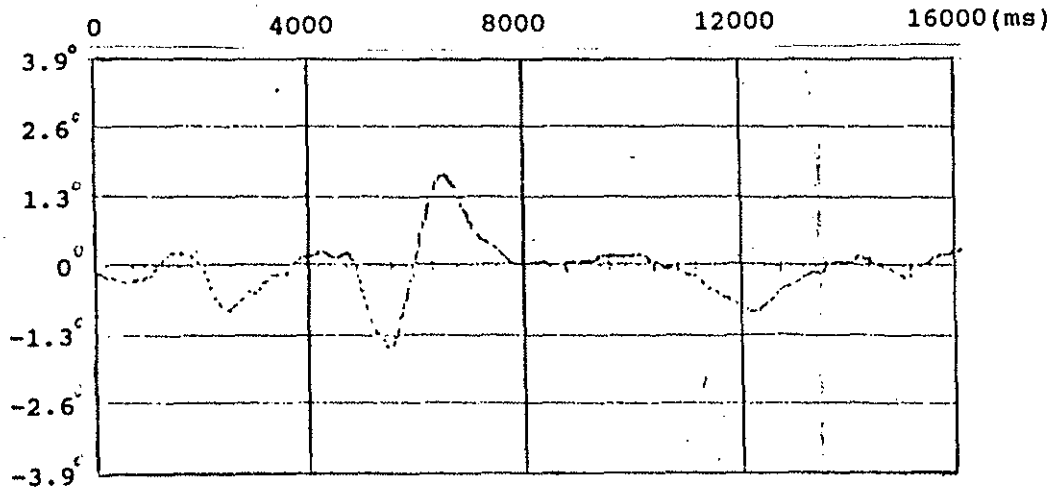

Fig.7

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