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THE SAFETY INVESTIGATION OF HELICOPTER HOVERING NEAR THE GROUND IN THE DESEERT AREAS

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Abstract

The harmfulnesses of sands and dusts environment induced by rotor to helicopter are discribed in this paper. The investigation results which are made by experiment and theory are presented. Finally a sets of countermeasures are indicated to reduced the harmfulnesses of induced sands and dusts environment to helicopter.

Notation

D	rotor diameter
H	the height of helicopter rotor above the ground with sands
P	rotor disk loading
R	rotor radius
V	velocity

1. Introduction

The flight feature of helicopter makes it to take off and land vertically or hover near the ground in the rough surface areas such as fields, grasslands, deserts and so on. However a bad induced sands and dusts environment was established around the helicopter at same time because of wash and reflection of rotor downwash flow which raises the sands and dusts from ground. The corrosive effects of sands on helicopter parts and elements reduced the service life of helicopter on which no equipment protecting sands is installed.

The survey results of helicopter operating at some deserts areas in china indicated that:

(1). Sands and dusts environment induced by rotor resulted in the lackege of engine oil and lubricant oil because the sealing washer of engine was wore out. Sometimes the blades of separator protecting sands into engine also have been broken.

(2). Induced sands and dusts worsen the rub condition in the surface between bearing and control system. As a result, the level of helicopter virbration was so high that it was too difficult to control. Several flight troubles were record because of the rapid wear and tear between the bearing and control system.

(3). Induced sands and dusts environment abraded the outboard of rotor blade, especially in the leading edge and the low surface of blade tip.

(4). Granular sands induced by rotor washdowm flow often stirckes the cockpit glasses. Sometimes the cockpit glasses were broken during the flight of nap—of—earth.

(5). The planting covers at actuator drived by hydraulic pressure were tore out because of the abrasion of sands and dusts. The result was the lackege of lubricant oil.

(6). Serious induced sands and dusts environment tore the plation covers of radar hood, landing gears and fuselage surface.

2. Experimental Investigation and Theoretical Analysis

The investigations were carried out in accordence with the harmfunesses. The purpose was to recognise the source of harmfulnesses in order to indicat an efficient protective measures.

It can be found that all of the harmfulnesses of sands and dusts inducde by rotor to helicopter were related with sands and dusts density and their forces at a given place by analysis the harmfulnesses mentioned above. So the key to overcome the harmfulnesses is to determine sands and dusts density and forces at a given place. If the density and forces were determined the problem is easy to resolve. However it is very difficult to determine the density and force at an arbitrary place in helicopter fuselage because the induced sands and dusts flow which greatly affects the density and force is very complex near fuselage. Forturenately the problem discussed here is intreasting in some particular places such as engine airflow inlet, sides of cockpit because the harmfulnesses in these areas are more interested.

When helicopter hovers near the ground, the different rotor disk loading and hovering altitude will result in different sands and dusts flow environment and then the different density and force. Therefore the experimental and theoretical analysis were carried out to study th sands and dusts flow, density and force at some particular place (engine airflow inlet, sides of cockpit) with different rotor disk loading and hovering altitude. The experimental device and measure equipment are illustrated in Fig. 1 and Fig. 2 respectively. Some theoretical results and test data about sands and dusts velocity is given in Fig. 3 . Fig. 4 is the test results of sands and dusts density which increase in the manner of logarithm with rotor disk loading at a constant experimental emvironment and hovering altitude. Theoretical and test results of sands and dusts forces at engine airflow inlet is shown in Table Ⅰ. It will be found that the force is little and the agreement between theory and experiment is acceptable .

According to the experimental and theoretical results the following main features can be obtained.

(1). The harmfulnesses of induced sands and dusts environment to helicopter are serious.

(2). Abrasion of blades; Sands greatly abrade the outboard parts of rotor blades, especially in the leading edge and the low surface of blade tip.

(3). Gathering of sands and dusts at rotor hub: A thick layer of sands and dusts covers on the rotor hub especially on the convex parts.

(4). covering with a thin layer of dusts on top surface of fuselage stabilizer: It was obviously to look this phenomenom. The cracks between fuselage and stabilizer were seeped with sands and dusts.

(5). Sands and dusts density is related with hovering altitude, loca—

tion at fuselage and disk loading. The density decreases with hovering altitude at constant disk loading and increases in the manner of logarithm with disk loading at constant hovering altitude.

(6). The force of induced sands and dusts on fuselage is little in hover. However, it may be greater if helicopter fly forward (or hover in wind) because bigger graunlar sands were raised by earth vortex and rushes to the cockpit.

3. Concluding Remarks

It is obviously from investigations that the induced sands and dusts environment which encountered by helicoper operating in some areas with dry climate, little vegetation and lager shifting sands is objective reality. Therefore we must face up to it and study it. In order to reduced the harms to helicopter some essential protective measures had to be used during the design of helicopter.

(1). Engine ought to be installed with improved equipment protecting sands and dusts . The importance of it has been understood by many designer in detail. So it is not necessary to discuss.

(2). there are serious abrasion of sands and dusts to the leading edge and the low surface of blade tip. Therefore the material which can endure great abrasion must be installed in this region. As we know the titnium alloy is excellent in the wear resistance. If the titanium alloy is covered in leading edge and low surface at outboard of blades the abrasion would be reduced greatly.

(3). To aviod exposition of control system in sands and dusts environment is very important. If difficult, some special sealing measures must be done. For example soft sealing washer glovess is installed in joint bearing to protecting the seeping of sands and dusts.

(4). When helicopter takes off in ground with graunlar sands high forward flight must begun at enough altitude as soon as possible to avoid the crash of bigger sands to cabin grasses. It is also important to increase the shock intensity of cockpit grasses.

(5). The sealing of oil, lubrication oil and hydraulic transmission systm has to be a good condition to avoid the seeping of sands and dusts.

Table I (g / cm^2)

h	0.6	1.3	2
Theoretical Value	0.43	0.32	0.25
Experimental Data	0.5	2.23	0.18

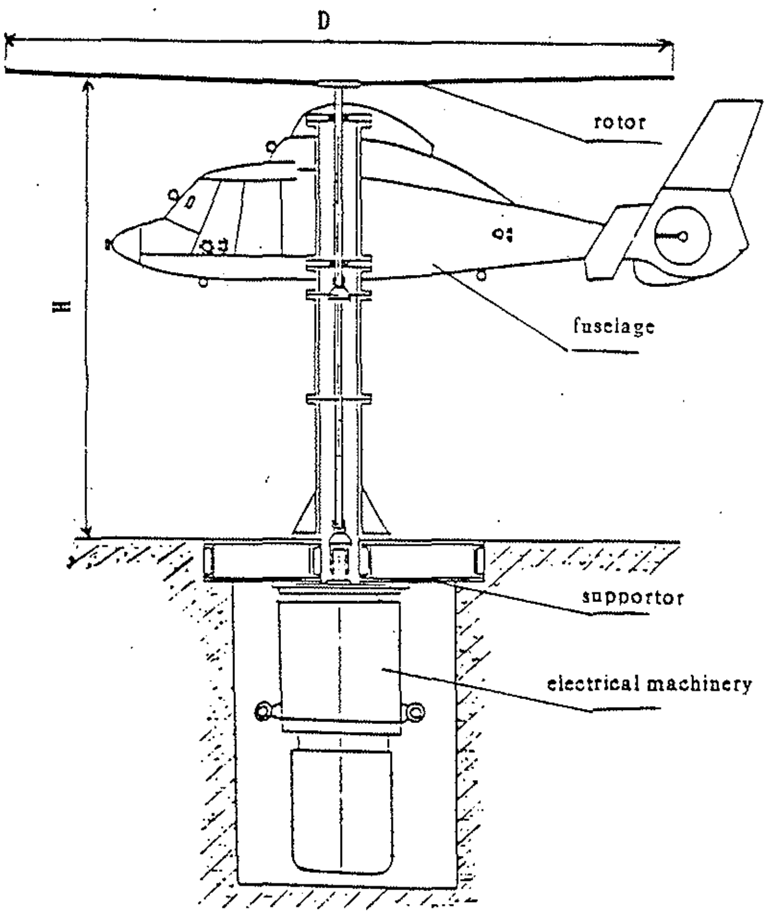


Fig. 1 Experimental Device

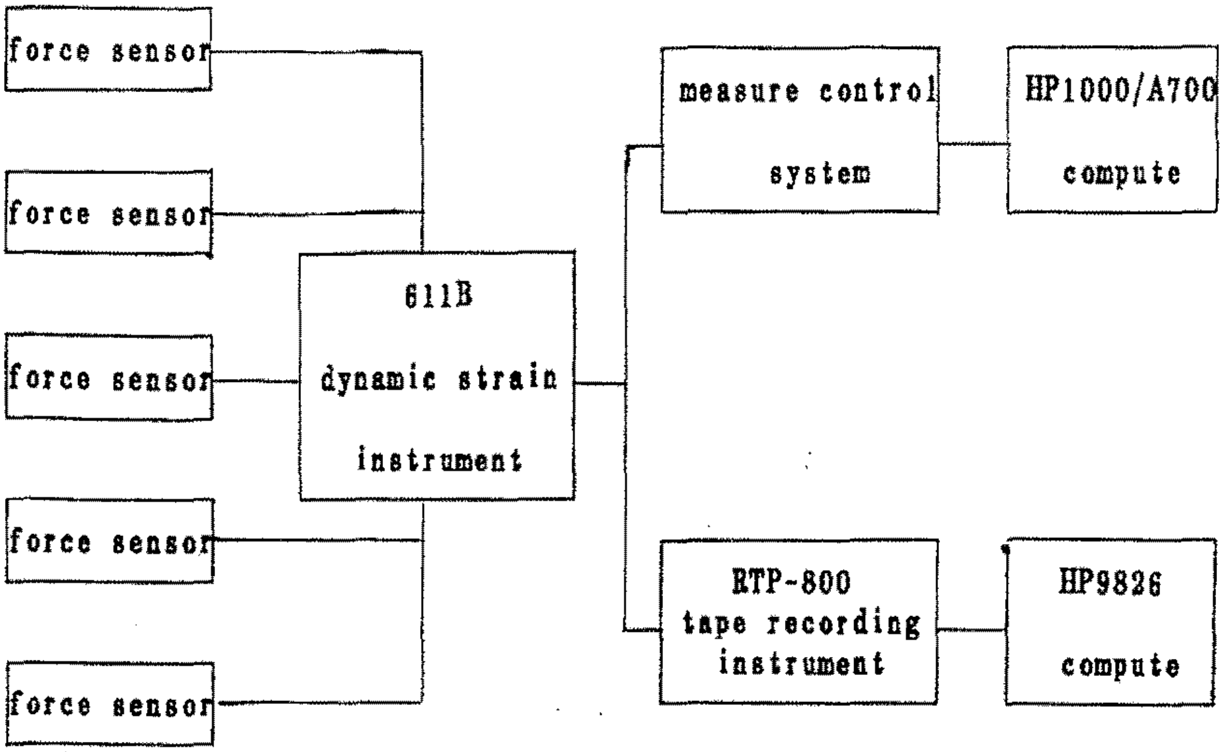


Fig. 2 Measure Instrument

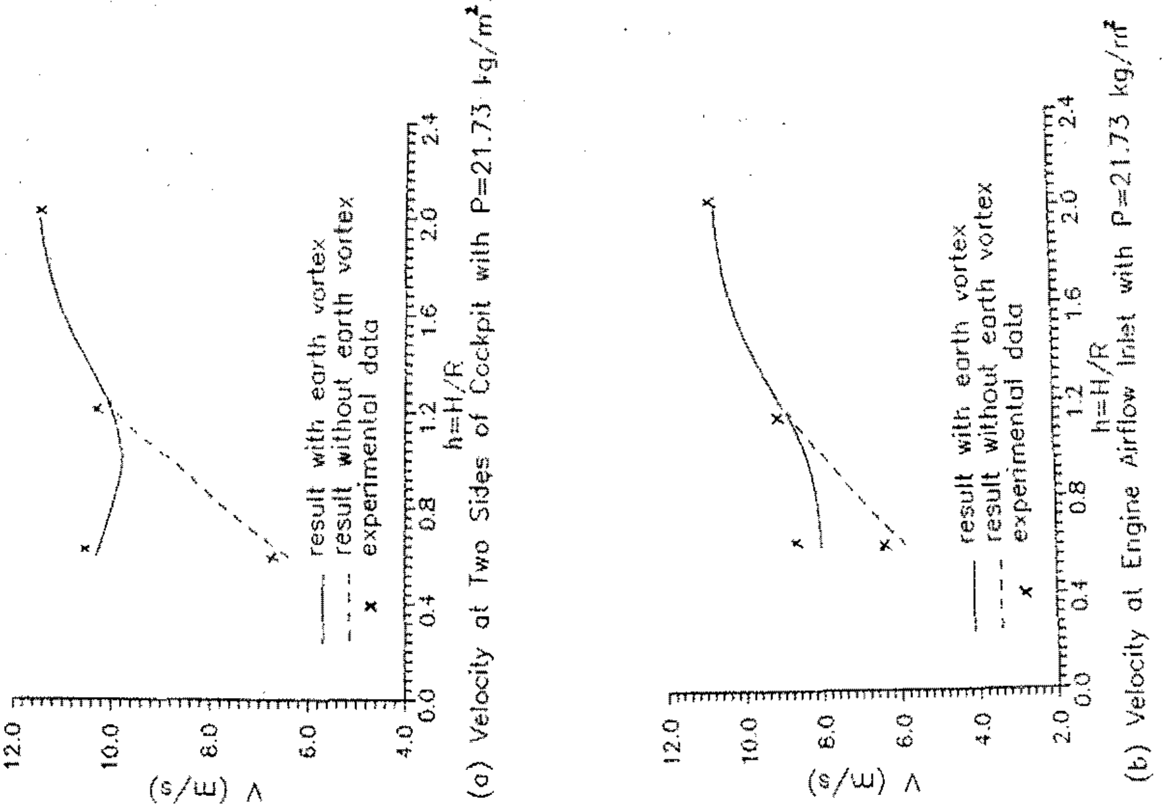
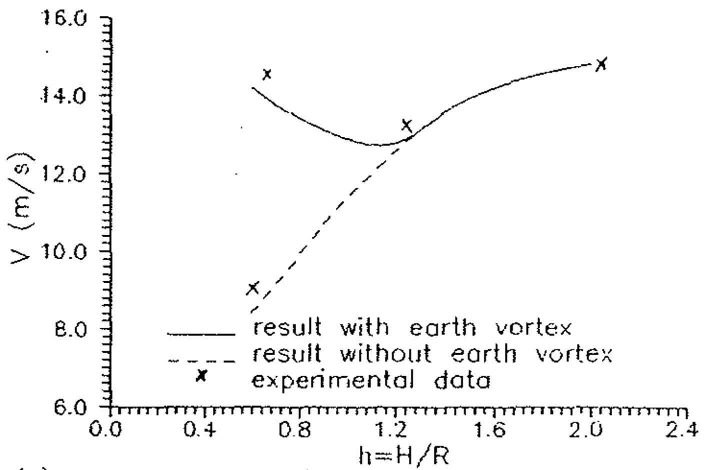
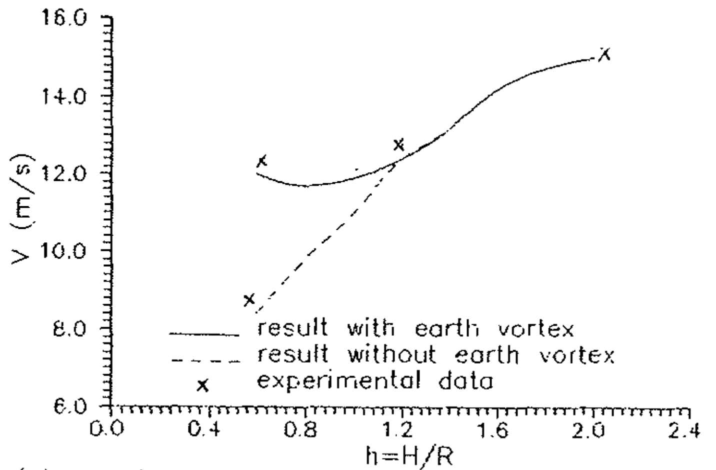


Fig. 3 Comparision of Velocity bewteen Theoretical Results and experimental data

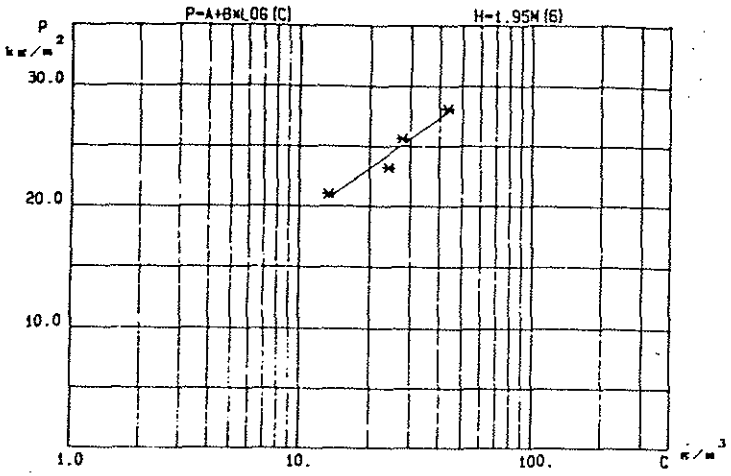


(c) Velocity at Two Sides of Cockpit with P=34.44 kg/m²

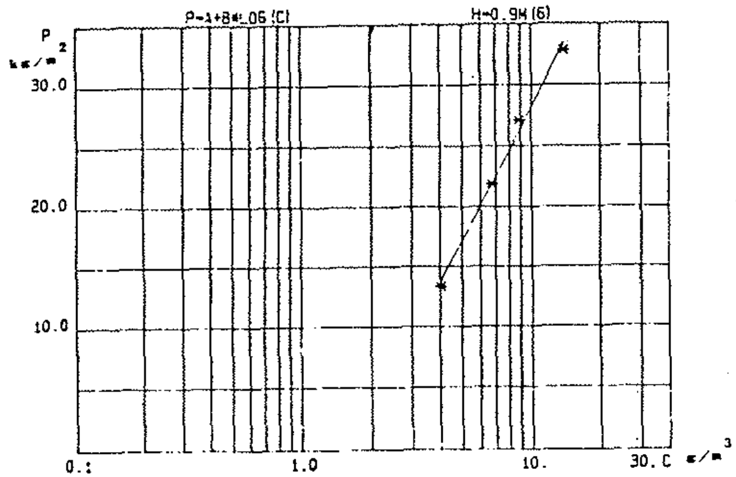


(d) Velocity at Engine Airflow Inlet with P=34.44 kg/m²

Fig. 3(continue) Comparison of Velocity bewteen Theoretical Results and experimental data



(a)



(b)

Fig. 4 The Relationship Between Density of Sands and Dusts and Rotor Disk Loading