Analysis of Causes and Countermeasures of Helicopter Accident from the Engineering Viewpoint

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ABSTRACT

The helicopter crashes result in pilot death, considerable economic loss, and potentially bad damage to nearby residents. Thus, there needs to be a thorough investigation on causes of helicopter accidents and establishment of the prevention measures before another crash repeats. In the present research, the accident data of the last 30 years from US Army, EU Helicopter, and Korea government agencies (Forest Service, Police Agency, National Emergency Management Agency, and etc.) were studied. The causes of the accidents were classified into three fundamental models: human error, mechanical error, environment error. Additionally, the technical countermeasure was proposed to reduce the accident caused by each error.

1. INTRODUCTION

Unlike other transportable vehicle, an aircraft flies on the sky. Thus, an aircraft accident brings a passenger’s death or severe injury. Meanwhile, it is notable that accident rate of rotorcraft is 3 times higher than that of fixed wing aircraft considering the ratio of the accident frequency to the number of each aircraft.

Helicopters play an essential role with unique abilities to hover, flight forward in low speed and take off/land vertically. These capabilities enable helicopters to carry out many distinctive tasks in both civilian and military missions. The advantages of helicopters often forced them to operate in the harsh flight conditions such as unclear sky with limited visibility, bad weather, and sky over the city surrounded by tall buildings. Then, the missions become quite dangerous for pilots, and the flight could go beyond the recommended flight condition. Consequently, the helicopters are very likely to crash. Additionally, it is well-known that handling helicopter is quite difficult and sensitive to pilot’s control mainly due to a yaw-roll coupling system. In this paper, the various helicopter accidents data were studied in depth. They are categorized into three depending on the primary cause, and the corresponding prevention measures were proposed.
2. HELICOPTER ACCIDENT CASE ANALYSIS

2.1 Helicopter Accidents Statistics

US NTSB (National Transportation Safety Board) classified the major causes of worldwide airline accidents as follows [1].

(1) Pilot (53%)
(2) Mechanical problem (21%)
(3) Bad weather (11%)
(4) Non-pilot (8%)
(5) Deliberate accident (6%)
(6) Etc. (1%)

Also, EHEST (European Helicopter Safety Team) investigated European helicopter accidents data from 2001-2005 [2]; the accidents mainly occurred in en-route, maneuvering, and approach and landing flights. EHEST analyzed that the reason for high percentage of fatal accident during the en route is due to more time at high speed during the phase.

2.2 Korea Helicopter Accident Statistics

In the present research, the causes of helicopter accidents were classified into three fundamental models [1]: human error, mechanical error, environment error.

(1) Human error: failure to emergency measures, failure to procedure, being careless in surrounding, etc.
(2) Mechanical error: machine defect, maintenance defect, etc.
(3) Environmental error: bad weather, unclear visibility, etc.

Public and civil helicopter accidents in Korea for last 30 years (1983-2012) were categorized by the models depending on their primary causes, and presented in Table 1. It shows similar trends with US NTSB’s study [1]. The highest factor is a human error, which is followed by a mechanical error, and an environment error. However, it seems to be disputable that only one type of error is responsible for each accident, and it is more likely that an overlap of several errors results in the accident [3].

Table 1. Public and Civil Helicopter Accident Statistics in Korea for the past 30 years

<table>
<thead>
<tr>
<th>Error</th>
<th>Human Error</th>
<th>Mechanical Error</th>
<th>Environmental Error</th>
<th>Etc.</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>49 (70%)</td>
<td>11 (15%)</td>
<td>8 (11%)</td>
<td>2 (3%)</td>
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CH47 helicopter of Korea Army Air Operations Command crashed into the Olympic Bridge in 2001, as shown in Fig. 2. During the installation of large sculpture, rotor blades hit the bridge and crashed. Aviation and Railway Accident Investigation Board reported that the pilot might fail to recognize the altitude change while there was unexpected downdraft [1][3]. This might be an example, which is caused
by the combination of a human error and environmental error.

2.3 US Military Helicopter Accidents Statistics

There have been many worldwide researches on helicopter accidents [1-5]. Fig. 3 shows the US Army helicopter accident status, which was reported at the 1st Asian/Australian Rotorcraft Forum and Exhibition in 2012 [4]. For the last 10 years (2002-2012), among the total 227 accidents, 179 accidents occurred in non-hostile situation while only 48 accidents occurred in hostile situation. This is a quite impressive data, which implies that a study of helicopter accident and its reduction remedy are urgently necessary.

Fig. 3. US Army Helicopter Accidents Status (2002-2012) [4]

3. COUNTERMEASURES OF HELICOPTER ACCIDENT

3.1 Accident Causes and the Corresponding Remedies

In order to reduce helicopter accidents specific countermeasures should be made according to each error. First ways to reduce accidents caused by human factor are as below.

1. Systematic training course and education should be established.
2. Employ pilots to increase efficiency and reduce workload.
3. Refrain over-confident flight.

Secondly ways to reduce accidents caused by mechanical factor are as below.

1. The supervisor should be trained to supervise the employees and maintain the quality.
2. In design stage priority should be given for the safety of rotocraft.

Finally methods to reduce accidents caused by environment factor are as below.

1. In bad weather conditions refrain from flight mission.
2. A system to inform the pilot and aviation workers about weather condition should be created.

3.2 Development of an Improved Simulator for Likely-to-Crash Flight Condition

The flow around a helicopter is quite complex due to the rotor wake flow, its interaction with the rotor blade and the fuselage. Moreover, the helicopter could face unexpected wind gust or bad weather condition. When it approaches the ground, the ground effect and the brown-out phenomena will disturb the flight. There are lots of situations which might bring the helicopter to crash. Among them, the authors focused on the case that the helicopter experiences dramatically perturbed motion and unbalanced attitude. The severe maneuver could happen by pilot’s being ignorant to flight instrument gauge values or any other environmental factors. In the case, it is likely that the surrounding flow physics becomes more complicated due to the wake flow and its influences to the fuselage and tail rotor. This surely changes the aerodynamic loadings. However, the conventional helicopter simulator for a pilot’s training cannot cover such an unexpected and complex wake-induced perturbed motion, which means that a helicopter pilot cannot really experience so-called likely-to-crash flight conditions in advance. Here is the authors’ suggestion. If there is an improved simulator which mimic the flight by considering the wake influences and the consequent flight
dynamics, the pilot can be trained for the likely-to-crash flight. Then, it is expected that the pilot survives the dangerous flight situation. Even though the suggestion sounds like very promising, it is still challenging to develop a fast computing and reasonably accurate aerodynamics/dynamics coupling code for a maneuver flight of a complete helicopter configuration. Fig. 6 shows the flow filed around a UH-60 in UTTAS pull-up maneuver flight, which is computed by KAIST. It is computed using the potential flow solver with the advanced surface pressure prediction method which can count for vorticity influence.

4. CONCLUSION

The helicopter is operating in a variety of industries and country transportation. Thus developing a more systematic safety management system is urgently required. Concern about the stability of the helicopter still resides due to frequent accidents. Likewise the importance of training for pilot is emphasized. The authors’ opinion is that prediction of helicopter behaviors during the severe maneuver condition is one of the essential conditions for reduction of accidents. For understanding and prevention of helicopter accidents, domestic and overseas accidents of helicopter are investigated and analyzed. Accurate aerodynamics/dynamics analysis program should be developed to prevent helicopter accidents. Thus, by using a result of the aerodynamics/dynamics simulation, it is expected to be prepared for emergency situation. Eliminating the essential cause of the accident is difficult, but accident frequency is expected to gradually decrease through the prevention measures. The authors hopefully expect that the present paper could contribute to reduce helicopter accident in the near future.

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