Field Study

Anthropometric Parameters for IAF Helicopter Pilots

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Abstract

Apart from the general anthropometric limits for all aircrew and a minimum stature height, no specific anthropometric parameters have been defined for helicopter aircrew of the IAF. Flying training for helicopter aircrew of the IAF is conducted on the Chetak aircraft, which has dynamic controls without trim switches. Since all helicopter aircrew of the IAF need to fly this aircraft before graduating to other helicopters, certain anthropometric compatibility issues associated with this aircraft have been discussed. Analysis of anthropometric measurements of 64 cadets of helicopter stream in the age group of 20-23 years was done and three (03) cadets corresponding to the lowest, middle and highest percentiles anthropometrically were seated in the Chetak cockpit to determine their ability to reach and operate all controls and panel switches. The various reaches of these cadets were analysed in conjunction with the ergonomic layout of the aircraft. The short statured pilot experienced difficulties in operation of the rudder pedals even after using a lumbar support pad. In addition, when this pilot operated the cyclic control and the brake on the ground simultaneously, he was unable to operate the rudder pedals properly. The problem of control accessibility in the Chetak helicopter is sufficiently significant to warrant a redefinition of anthropometric requirements for the IAF helicopter aircrew. It is recommended that a minimum leg length of 105 cm should be instituted for helicopter aircrew of the IAF.

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Flying is a closed loop continuous task best performed with good man machine dynamics. For successful and safe operation of aircraft, pilots must be able to operate controls effectively and be able to see all displays clearly. Designers need to take full account of human diversity in order to accommodate variations in various anthropometric parameters [1]. The Indian Air Force has laid down anthropometric parameters for all aircrew flying fighter aircraft. However, apart from the general anthropometric limits for all aircrew and a minimum stature height of 162.5 cm, no specific anthropometric parameters have been defined for helicopter aircrew of the IAF [2].

Flying training for helicopter aircrew of the IAF is conducted on the Chetak aircraft. This aircraft, an indigenous modification of the French Alouette III, has dynamic controls without trim switches. This effectively implies that the pilot has to actively control the aircraft all the time. Problems in accessing any of the controls due to anthropometric limitations can have serious ramifications on transfer of training and flight safety. Anecdotal evidence suggests that short statured aircrew experience difficulties in operating the rudder pedals of the said aircraft while flying. Most of them resort to ad hoc remedial measures like using a lumbar support pad which allows them to

Fig 1: Helicopter aircrew using lumbar pad

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sit slightly forward in the aircraft seat (Fig. 1). Since all helicopter aircrew of the IAF need to fly this aircraft before graduating to other helicopters, anthropometric compatibility issues related to this aircraft needs to be addressed. This paper aims to examine these anthropometric compatibility issues and to define anthropometric limits for helicopter aircrew of the Indian Air Force.

Methods

The anthropometric measurements of 64 cadets in the age group of 20-23 years, who had been allotted the helicopter stream after completion of basic flying training, were analysed using Microsoft Excel® software. Of these, three (03) cadets who corresponded to the lowest, middle and highest percentiles in terms of stature height, leg length and thigh length were seated in the Chetak cockpit to determine their ability to reach and operate all controls and panel switches. The various reaches of these cadets were analysed in conjunction with the ergonomic layout of the aircraft.

Results

The mean height of the cadets was found to be 174.7 ± 24 cm. The average leg length was 108.3 ± 9.8 cm. The mean thigh length was found to be 60 ± 4.6 cm. The percentile values of the three subjects in terms of all the three parameters are given in Table: 2.

Table 2: Percentiles of 03 subjects for different anthropometric parameters

	Subject 1	Subject 2	Subject 3
Height	5	90	95
Leg length	5	70	95
Thigh Length	3	50	90

All cadets had adequate clearances from all aircraft structures. None of the cadets had any problem in reaching the main instrument panel of the aircraft with the seat harness fully tightened; functional arm reach of all cadets was found to be adequate. The tallest pilot and average statured pilot were able to operate the rudder pedals without any difficulty indicating an adequate leg length and thigh length. However, the short statured pilot was found to be experiencing difficulties in operation of the rudder pedals even after using a 5 cm thick lumbar support pad. In addition, when this pilot operated the cyclic control and the brake on the ground simultaneously, he was unable to operate the rudder pedals properly.

Discussion

The IAF has laid down anthropometric parameters for fighter aircrew flying different aircraft. However, there are no such special laid down requirements for helicopter aircrew. As of now, the anthropometric requirements for helicopter aircrew of the IAF are the same as for flight test engineers and WSOs of Su-30s and are as given in Table-1 [2].

Table 1: Anthropometric parameters for helicopter aircrew

Anthropometric Parameter	Range (cm) Min	Max
Stature height	162.5	-
Leg length	99	120
Thigh length	-	64

Fig. 2: Thigh tangent angle in the aircraft

The Chetak helicopter has certain peculiarities due to which the problem of aircrew – aircraft

Fig. 3: Knee flexion in a tall pilot

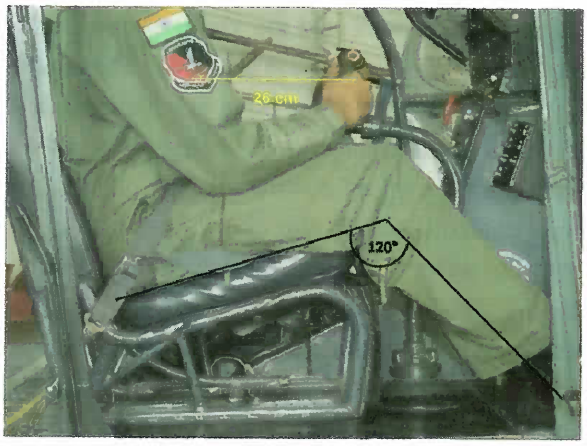

Fig.4: Knee flexion in a short pilot

compatibility is compounded. The seat pan of the aircraft is inclined and makes an angle of 20° between the thigh tangent line and the bottom tangent line (thigh tangent angle) (Fig.-2).

Even though this angle is within the limits specified by the relevant Mil Std [3], this inclination prevents the aircrew with a shorter leg length from extending his/her knee completely for operation of the rudder pedals. The shorter pilot's knee and ankle joints are relatively extended during rudder pedal operation, even with the rudders in the fully aft position and the seat in the fully forward position, thus leaving little scope for further extension (Figs. 3, 4, 5, 6). Thus, an aircrew with a shorter thigh length and leg length finds it difficult to operate the rudders as compared to one who has longer leg and thigh lengths. The problem is compounded by the fact that the aircraft in question has only fore and aft adjustment of the aircrew seat and no vertical adjustment.

Another problem faced by shorter aircrew is an inability to rest their right arm on their right thigh while flying without lumbar cushions. This position is known as a "spot weld," (Fig. 3) and is usually considered necessary to achieve stability to fly [4]. Rotary-wing pilots are subject to continuous vibrational stress during flying and tend to fly in a crouched position [5, 6], which is almost universal due to their desire to place the right forearm on the right thigh. This "spot weld" is necessary to hold

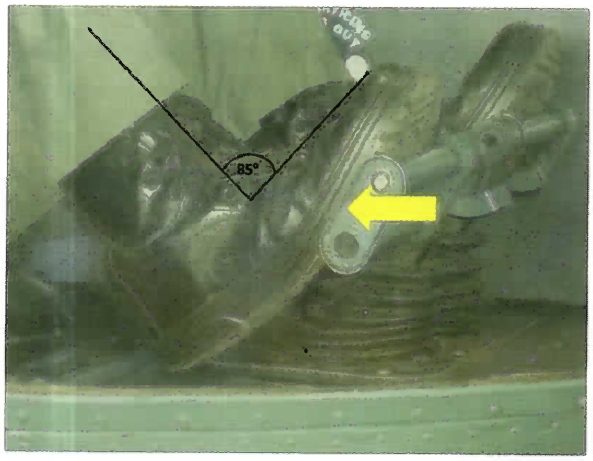

Fig. 5: Ankle position in tall pilot while operating rudder pedals

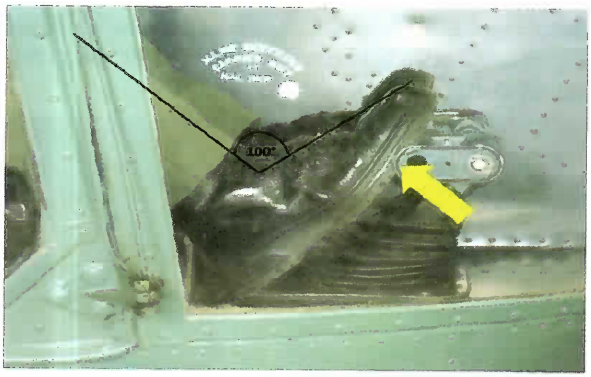

Fig. 6: Ankle position in short pilot while operating rudder pedals

the cyclic control firmly while undergoing vibration. Inability to keep the right forearm on the right thigh during flying results in jerky motion of the cyclic control (Fig. 7).

Moreover, the distance between the control

grip reference point and the xiphisternum is also less in the shorter aircrew (Figs. 3, 4). The control grip reference point is the point at which the crew member's second finger (middle digit) is in contact with the forward or downward face of any grip type control such as the control stick [7]. To compensate for the extended knee, the short aircrew use a lumbar support cushion which shifts the seat reference point [8] forward by 5 cm. This forward movement allows the aircrew to flex the knee by an additional 5 degrees, but at the same time, reduces the distance between the control grip reference point and the xiphisternum by around 5 cm, therebychanging the aircrew's grip on the cyclic control and in turn, making stick motion jerky (Figs. 8,9,10).

Fig. 7: Separation between right forearm and thigh in a short pilot

Fig. 8: Position of cyclic control in aircrew using lumbar cushion

The brake in the aircraft, which is used during ground taxiing, is located in between the two seats. The same is operated by a pumping action by the aircrew. The brake lever is at a low level, close to the aircraft floor and for operating it, the aircrew has to bend sideways (Fig. 11). Simultaneous operation of the cyclic control and the brake lever does not pose any problems for the taller aircrew. However, in shorter aircrew, it has been reported that this operation of multiple controls, at times results in elevation of the foot off the rudder pedals. It is well documented that the seat and control

Fig. 9: Normal grip on cyclic control

Fig. 10: Changed grip on the cyclic in a short pilot

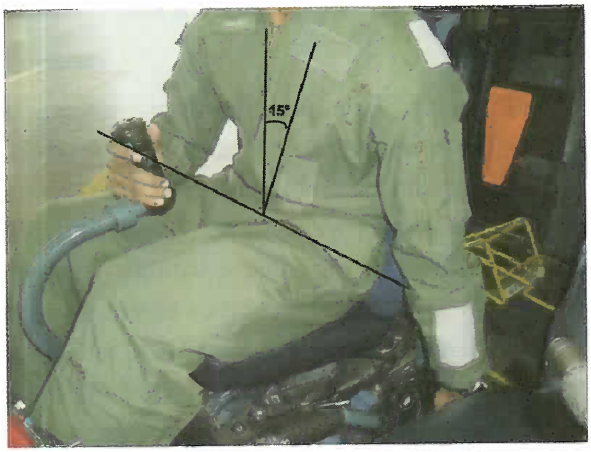

Fig. 11: Side tilt during brake operation

configuration in most helicopters force the pilot to bend forward in his/her seat and lean slightly to the left [9, 10]. Furthermore, the pilot must maintain this position during most of the time he/she is at the controls, since full control of the aircraft requires simultaneous input from all four extremities [11].

Keeping in view these problems associated with helicopter flying, numerous air forces around the world have defined leg length limits for their helicopter aircrew [4, 12]. However, such parameters have not been defined in the Indian Air Force.

Conclusion

This study shows that the problem of control accessibility in the Chetak helicopter is sufficiently significant to warrant a re-definition of anthropometric requirements for the IAF helicopter aircrew. Institution of a minimum limit for leg length in this regard will go a long way in avoiding unnecessary attrition of trainees during their helicopter flying training and will also substantially help in promoting flight safety and mission effectiveness.

Recommendations

It is recommended that a minimum leg length of 105 cm should be instituted for helicopter aircrew of the IAF. This leg length corresponds to approximately the 30th percentile of our sample population. Since tall pilots with longer legs have no problems in operating all controls of the aircraft, an upper limit for this parameter need not be defined.

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