CONCEPT USED TO DESIGN MIL MI-8 AS SHOWN M. L. MIL DIARY NOTES AND SKETCHES

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Abstract

The Mi-8 middle class helicopter whose maiden flight was made 40 years ago is still the world's most flying helicopter. Its fleet amounts to 3,220 units. About 12,000 aircraft have been manufactured till now.
The success of this popular rotorcraft can be attributed to its concept, research in aerodynamics and flight dynamics, then advanced design and production. Many versions have been derived from its basic configurations.
The notes and sketches fixed in M. L. Mil diary make it possible to follow the Designer's concept.

Fig. 1 Mi-8 Helicopter. 1962

Introduction

Helicopters belonging to the Mi-8/Mi-17 family have been a success in the whole world among 24-30-seat military transport helicopters. The total fleet of the above Mil helicopters amounts to 3,220 units, thus exceeding the number of all other types of helicopters, including the ubiquitous Bell 204/205 8-14-seat utility and transport helicopters whose fleet amounts to 3,190 units. (Ref. 1) More than 10,000 helicopters of that family in different modifications have been produced so far. They are second to none as far as the number of their modifications is concerned. The Kazan Helicopter Plant and Ulan-Ude Aircraft Plant started mass production in 1965 and 1970 respectively. (Fig. 1)
What is the reason for this success?
The success can be attributed not only to the skilful design and producibility of these famous aircraft. There are quite many examples in the history of aviation when a helicopter successfully designed and flight tested could not find its place in real life. Thus, the V-12 helicopter, an absolute record-breaker in payload capability, that was presented at the Le Bourget Air Show in 1971, has never been produced due to the change of the war doctrine. The missile it should have been able to deliver was not put into production.

1 Dr. Mil as a Conceptualist

First of all, Dr. Mil was a brilliant conceptualist. Each time he conceived a new helicopter, he thoroughly thought over the concept of its utilisation. As his colleagues remember, preliminary work prior to initial design took 4-5 years. «The chief designer, -wrote Dr. Mil, - has two tasks to solve:
1.To find a solution ensuring high tactical performance for the given payload and flight performance; it should be controllable and comfortable for pilots.
2.To design an aircraft that is easy to operate; it means maintainability, reliability and long time limits.»
In the late 1950-s the first generation Mi-4 helicopter powered by a piston engine was produced in great quantities. It was a great success when used for military and civil purposes. It was sold on the world market.

«In designing the Mi-4 the problems were as follows: tail rotor design, main rotor flutter and hydraulic system design. We mastered the science and solved the problems».
The Mi-4 modification and success laid the foundation for development of the second generation helicopters powered by turbine engines and having the same main rotor system. Instead of carrying 1,600 kgf (or 16 troops) over 400 km, the new helicopter powered by turbine engines could deliver 2,500-3,000 kgf (or 25-28 troops) to the same distance. To do this, the fuselage should be larger, and the power/weight ratio should be greater. The Mi-8 concept is the continuation of the Mi-4 one. However, to persuade the military and get the required finances, Dr. Mil had to employ an artifice: to present the new helicopter as a modification of the Mi-4 powered by a turbine engines. In this case the main and tail rotor as well as all other major components remained the same.
Dr. Mil believed that in time «the helicopters would be used as transport means to a greater extent; as a result, some certain type, or, to be more exact, specimens of this or that category would the established, just like it happened to motor transport». In accordance with the Designer's concept, the future Mi-8 should replace light fixed-wing aircraft in commuter lines delivering passengers from airports to towns and cities located as far as 400 km maximum, or if it is a military version, to deliver a squad of up to 24 fully equipped troops. Time has shown that Dr. Mil guessed the size of the medium category helicopter right, i.e.. the helicopter capable of carrying 3,000-kgf load or 25-30 passengers that turned out to be most popular. The internal dimensions of the cargo cabin turned out to be a success as well (1.8 m high, 2.3 m wide and 5.34/6.36 m long for cargo/passenger versions). (Fig. 2) A medium size man could enter the cabin without bending down. The tail boom was high enough allowing a car to drive into the cabin. The opened lightweight clam-shell doors (that were as thick as an egg shell as the designers used to joke) and the loading ramp when lowered made it easy for the car to drive in. A spacious and comfortable cargo cabin provided a successful operation of the helicopter in performing special tasks in different branches of our national economy.

The work on designing the helicopter began in 1957-58, long before the production of the turbine engine started and the Customer's request for proposal was approved. Preliminary calculations for different engine power ratings were made, the main rotor diameter and the tail boom length were selected. The weights were calculated before the conceptual design started, thus selecting a configuration having the highest weight ratio. Aerodynamicists were calculating the main rotor lift. At the same time the Design Bureau was developing the Mi-6 helicopter powered by two turbine engines. In the course of the Mi-6 testing the aerodynamical methods used for calculations was improved. The previous method using the Glauert's theory was inapplicable due to high blade tip speeds and airspeeds. It should be noted that all the achievements made by the Mil Design Bureau in developing the Mi-1, Mi-4, Mi-6 were used in designing of the Mi-2 and Mi-8 helicopters of the second generation in the 1960

2. Helicopter Turbine Engines

The Design Bureau engaged in designing heavy-lift helicopters (Mi-6 and Mi-10) could not start to upgrade the Mi-1 light and Mi-4 medium helicopters by equipping them with turbine engines. It could also be attributed to the fact that no suitable turbine engines were available. Dr. Mil in his work entitled «Aircraft Efficiency» (Ref. 2) showed that turbine engines installed in the helicopter provided great advantages for this type of aircraft as compared to transport fixed-wing aircraft. «Utilisation of turbine engines will result in a revolution in the helicopter industry which will be more uproarious than in the fixed-wing aircraft industry.» The new helicopter powerplant comprising turbine engines turned out to be 4-5 times lighter by weight than the old one. More lightweight engines automatically provided weight saving of the helicopter structure itself. «An engine 1 kgf lighter made it possible to reduce the takeoff weight of the helicopter by 3-4 kgf for the same given payload».
The first V-8 prototype was powered by one turboshaft engine designed by the Ivchenko Design Bureau. It was AI-24 V of 1,900 shp. The maiden flight was made on June 24, 1961. The AI-24 engine designed for fixed-

wing aircraft was updated so that it could be used by helicopters. Its performance as far as the weight ratio and specific fuel consumption was not good enough. Dr. Mil managed to convince the Government to adopt a resolution on developing a new turbine engine of 1,200 hp. In those times the helicopters were considered to play second fiddle in aviation, and it was the first time that an order to develop a helicopter engine was obtained. Dr. Mil paid a great attention to the problems of developing engines, published scientific papers where he proved that more efficient engines from the point of view of the weight ratio and specific fuel consumption were a must. Any helicopter powered by a heavy engine is expensive not only in production, but in operation as well (due to higher depreciation costs and greater fuel consumption). Fig. 3 shows a sheet from the 1965 diary where the specific fuel consumption of the S-65 and Mi-8 are compared by him. He suggested that the chamber compression ratio should be increased and the number of the engine stages should be increased by two, as a minimum to obtain 1,700 shp. Here he also proposed an upgrade of the helicopter by increasing the cabin length by 1 m. Later on, this particular feature was implemented in the Mi-18 helicopter.

The new TV2-117 engines and main gear box developed by the Isotov Design Bureau made it possible to design a twin-engined version. The engines developed takeoff power of 1,500 shp. Their total power enabled the helicopter to continue level flight without descent with one engine inoperative. The V-8 (Mi-8) powered by two TV2-117 engines became airborne only a year later, on September 17, 1962.

Dr. Mil pondered on the problem of how to reduce vibration on the Mi-8. Fig. 4 presents his idea of changing the main rotor axis tilt to change the CG position. He also supposed to use energy absorbing seats for pilots. It should be noted that nowadays these Mi-8 characteristics are within the standard ones although the vibration requirements have become more stringent.

3. Main rotor

A five-bladed main rotor was designed for the Mi-8 using the blades produced for the Mi-4. Some structural members of the blade were replaced by reinforced ones; an electro-thermal anti-icing system as well as a blade damage indicator were introduced. Fig. 5 presents a new composite structure for the Mi-8 blade.

The all-metal structure of the blade has not been changed so far. The service life of the blade has significantly been increased by using improved manufacturing processes. The main rotor diameter remained the same, i.e. 21.3 m, although the engine power had increased by 1.5 times . It proves the blade was designed with a great margin of safety.

And the helicopter itself was designed so that it had a growth potential. It is second to none in the world as far as the number of modifications is concerned.

Oleg Bakhov, one of Dr. Mil's followers, now a leading designer, considers that the cabin designed to provide comfort, and the high tail boom were a display of the insight characteristic of a genius. That was why the helicopter has been used so widely in the national economy. The blades of the main rotor of greater diameter made it possible to increase the engine power in the future (as the TV2 engines were quite «weak») withstanding multiple increased loads.

Dr. Mil himself highly appreciated the significance of his work in designing second generation helicopters. «If I could manage to develop these aircraft and put them into quantity production, then it would become clear that that my life has not been lived for nothing, and, what essential, the country could obtain serviceable and cost-efficient aircraft». (1963).

Now we can state that the Mi-8 helicopters have been flying for more than 40 years and will still live a long life.

References

[1] E. Ruzitsky, " Development of World Helicopter Market" , Military markets, v.2, N 6, p.24, 2002, Moscow

[2] M.. L . Mil. "Aircraft Efficiency", Aircraft and Spacecraft N 8, p.17, 1965, Moscow

4.Figures

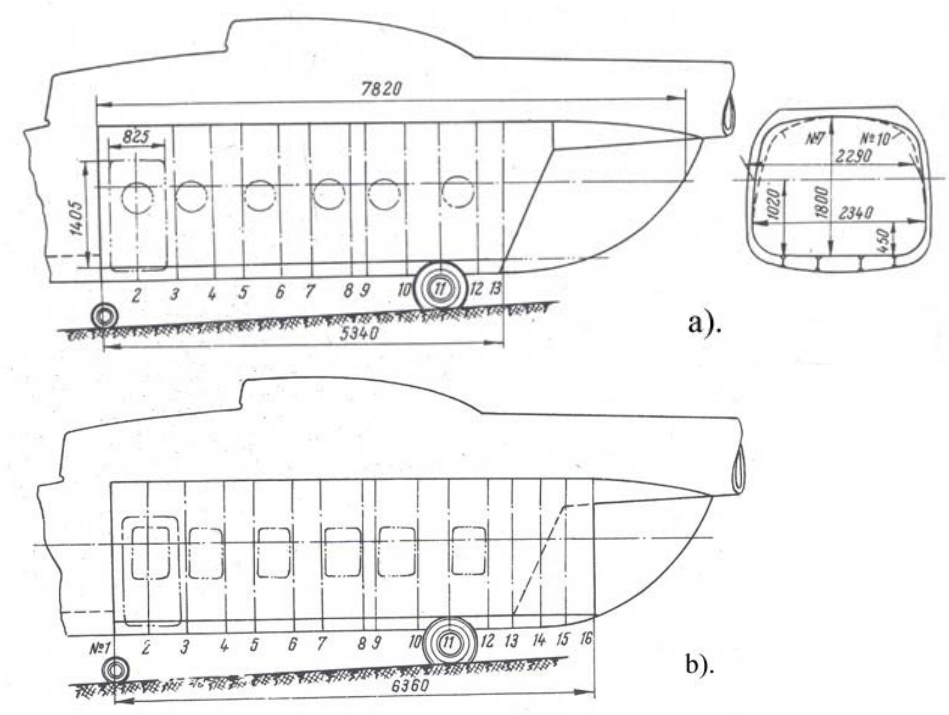

Fig.. 2 The internal dimensions of the Mi-8 cabin , a) cargo cabin, b) passenger cabin.

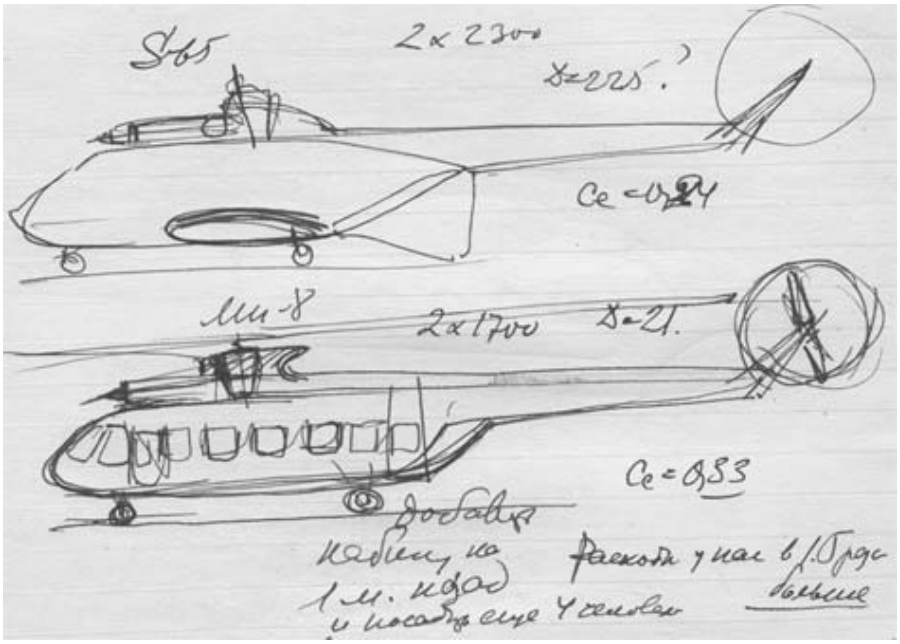

Fig . 3 Specific fuel consumption of S-65 (Ce=0,24) and Mi-8 (Ce=0,33). The 1965 diary.

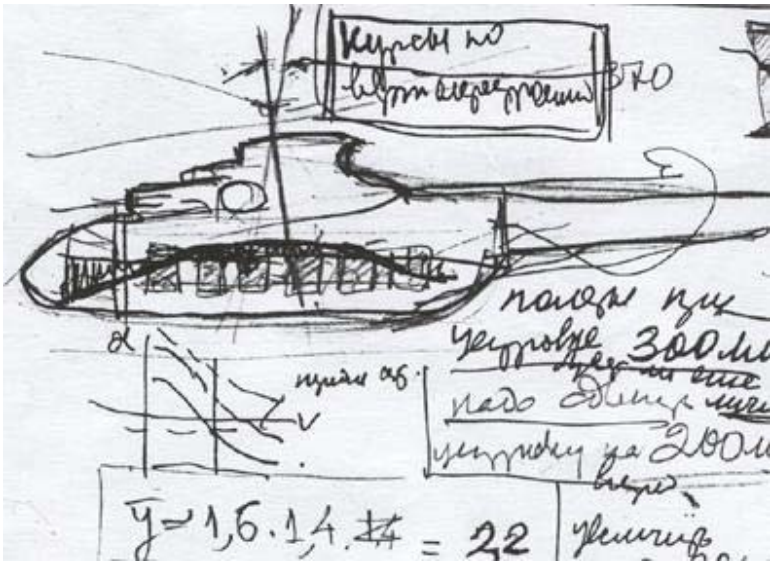

Fig. 4 Changing the main rotor position to reduce vibrations. The 1962 diary.

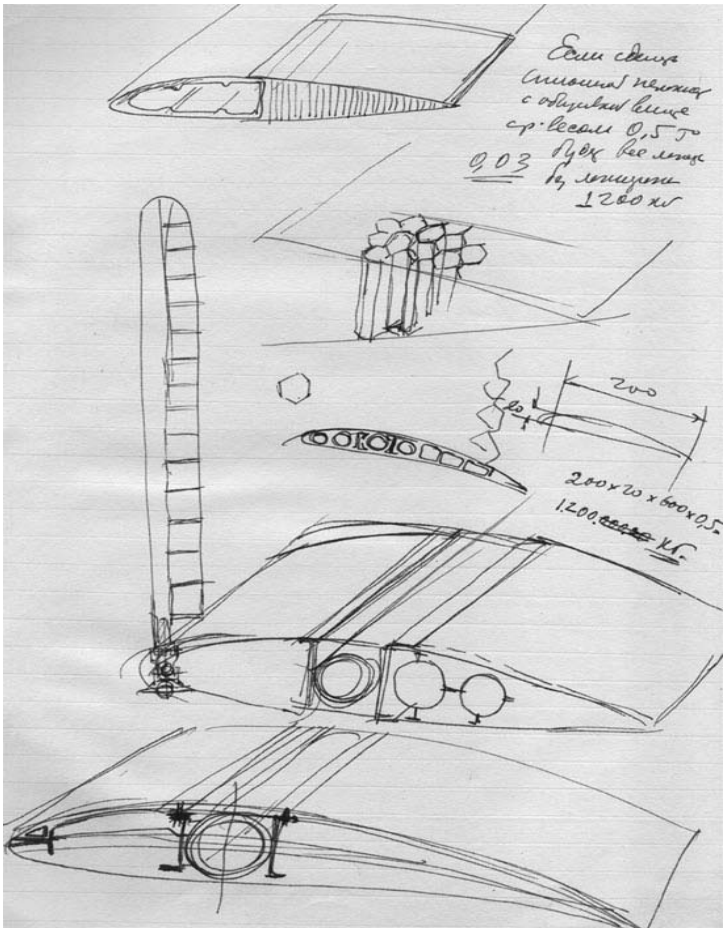

Fig. 5 Composite blade structure for the Mi-8 Helicopter. The 1965 diary.