Karakán

one-seater performance glider

Designed by Lajos Rotter

Built by the "Ezermester" Scout Group of the Hungarian State Machine Factory

At the end of 1932 nearly thirty gliders existed in Hungary. Of these only the three German designed but Hungarian built *Professors* can be regarded as high performance gliders. The Scout Flyers' intention was to participate with a Hungarian designed and built high performance glider at the Scout World Jamboree which would have been held at Gödöllő in August of 1933. So Lajos Rotter had been commissioned by the Hungarian Scout Association to design a high performance glider. At that time Rotter was known not only as the designer of the FEIRO aeroplanes but because of his activity on introducing gliding in Hungary.

At those times a disigner could only be occupied in his free time to design or control the construction of a glider, and - in this case - even whithout the hope of any kind of compensation. So Rotter designed the glider in addition to his everyday professional work. The eager help of the examination mechanical engineering student, Ernő Rubik, greatly contributed to the quick and precise construction. Rubik on the request of the Hungarian Aero Association prepared the detailed drawings for production as well.

It was an important aspect of the designing work that the builders of the glider had previously seen only primaries, as well as that the allocated small credit required economic building activity. In such circumstances aerodynamically the best, however at the same time the less expensive and easily realizable solutions were to be selected. Today it is impossible to establish what degree Rotter relied consciously on already existing forein examples. However knowing the contemporary gliders original characteristics of *Karakán* can be distinguished.

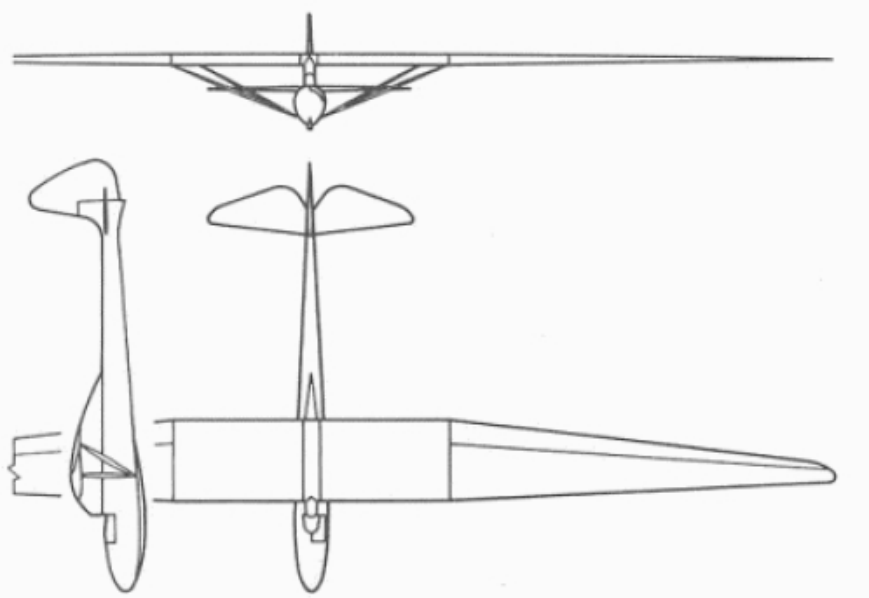


Fig. 1. *The Wien*

At that time the *Professor*'s elaborated version, the *Wien* was among the best gliders (Fig. 20). This was the glider the pilot of which first left conciously the slopes and used climb indicator to find rising air. (Span 19,10 m, aspect ratio 20, airfoil modified Gö 549. To the rectangle wing center part trapezoid outer wing panels were connected, and the wings were strutted.)

Rotter developed further the basic concept of the *Wien*. For the *Karakán* a bigger span was selected then that of the *Wien,* applying the same aspect ratio. Taking into account the special Hungarian atmospheric conditions a completely new airfoil was created, and to better the glider aerodynamic efficiency as well as the pilot's comfort a new fuselage form was developed by which - probably first time in the world - the best aerodynamic form and the better view were united.

The quality of the *Karakán* speaks highly on the ability and work of her builders. Especially Kálmán Fodor, Károly Léber, József Opata, Mihály Markó and Ádám Bartha excelled.

The glider's final assembly and finish were done in the workshop of the Sportflying Society of the Thechnical University (MSrE). Then the gliding section of the Society did not existed, but the workshop had gained valuable experience buildig a series of motor planes. The work of varnishing the *Karakán* was in progress when the Jamboree was opened. She was ready in the morning of 3rd of August and she was transported to Gödöllő in the same afternoon. At 4th of August Frigyes Hefty made two few seconds glidings launched by bungee-cord. Then came Rotter but he was launched by aerotow. "... she flies nicely, it can be felt that it is a huge glider. You are sitting quite forward of the huge, steady wings in a cellon covered cabin protected from any air current, hearing - specifically in aerotow - the whistling-bellowing sound of the machine. The fuselage beeing deep in front gives the feeling that you are sitting in the head of a bull running with hanging down neck."

The test flights of the glider were accomplished with these three takeoffs and not even a screw required fastening. Rotter was already unperturbed since "in spite of the abnormal high wing load [14,4 kg/m^2 - note of the author], which was regarded as important by me because of flying in the gusty air of our Flatland, with the new airfoil the glider's sinking speed will be adequate in thermals as well."

Rotter's confidence was not unfounded. With the *Karakán* - registered as C-0401 - barely 54 hours after her first flight broke a national record: launched by aerotow Rotter flew from Gödöllő to Kál and with this 64 km distance flight he fulfilled the first leg of his Siver C badge (No. 19 in the world). In Hungary this was the first flight using only thermals (if do not take into account the Polish K. Kula's flight at the previous day when he landed on the Haller market place in Budapest.)

At August 8 the first cloudflying in Hungary occured. With the *Karakán* Rotter, performing 20 seconds circles while on the airspeed indicator 40 km/h flying speed was shown, climbed to 1840 m altitude. With this flight he broke his previous distance records as well (Veresegyház-Szolnok, 84 km, 819 m).

So the *Karakán* represented Hungarian gliding well in the Jamboree, where altogether 18 gliders (of which 6 gliders came from Poland and one from Austria) participated. The *Karakán* produced sensation among the foreign participants rightly with her robust structure, fine contours and her results. The world's first Silver C badge pilot (R. Kronfeld) flew with the *Karakán* twice.

The successes of the *Karakán* were not finished with these flights. After the Jamboree had been closed down she was transported to Hármashatárhegy from where her remarkable flights were continued.

* It is not in contrast with the aim of this book if the most important results of this successful Hungarian glider will be listed here. March 11, 1934: 50 km distance flight only on slopes by way of Hármashatárhegy-Nagy Kevély-Cserhát-Bicske. July 15, 1934: The first cold-front flight in Hungary. June 30, 1934: Hármashatárhegy-Szárcsa, 274,8 km, Hungarian distance record. Oktober 7-8, 1934: 24 hours 14 minutes flight over Hármashatárhegy, again a new Hungarian record.

The era of thermal flights in Hungary started with *Karakán*. In addition to Rotter the Silver C badge was earned with *Karakán* by Tibor Steff, Béla Tardos-Tatarek, Ödön Török, dr. Ferenc Doleviczényi, Sándor Kemény, György Ozsdolai, Tibor Sárszegi, and the first aerobatic flights with a glider in Hungary were performed with the *Karakán* by Rotter, Bánhidi and then Steff at June 30, 1934.

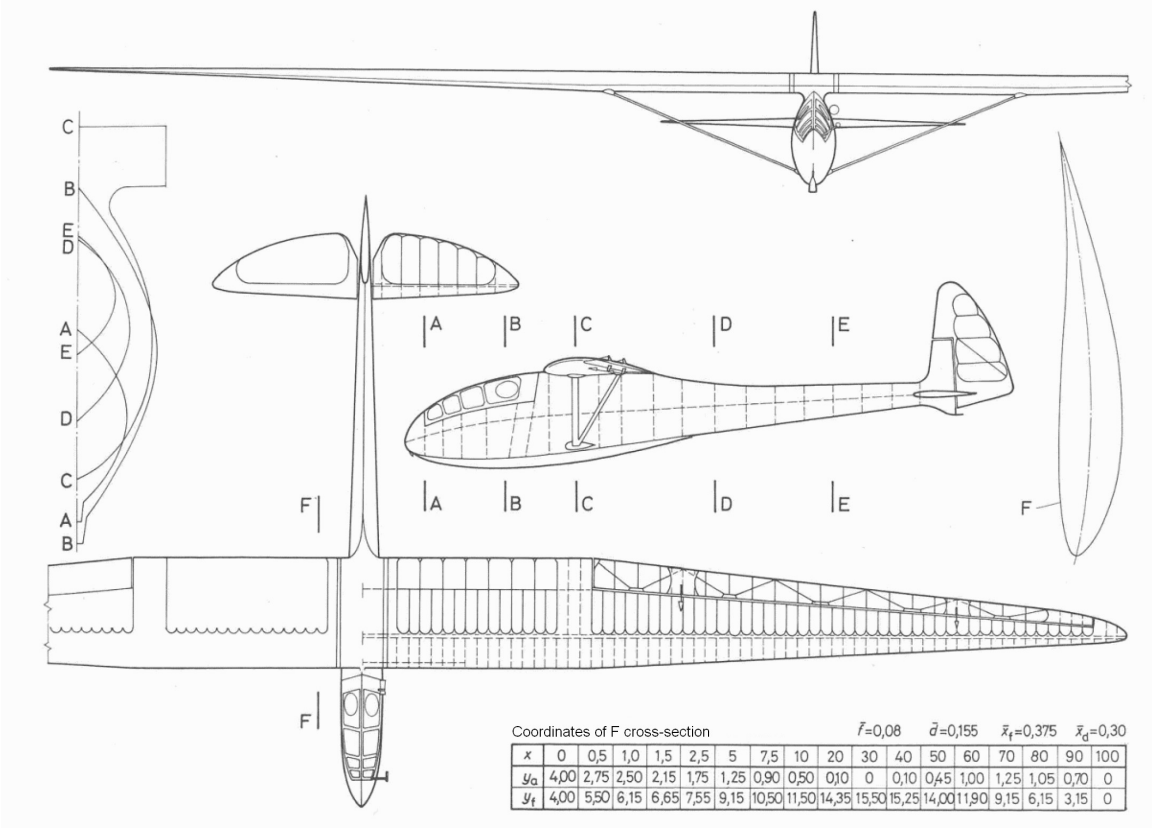
It has to be mentioned among the successes of the *Karakán* that at the international gliding contest organized on the occasion of the ISTUS Conference held in Budapest at May, 1936, in the distance category Rotter was the first having leaved behind the German Dittmar, and in the altitude gain category Steff was the runner up behind Dittmar.

The first appearance of Hungarian gliding pilots in a foreign country was when Steff participated with the *Karakán* at the ISTUS-competition in Salzburg in 1937.

According to her survived glider-logbook the *Karakán*'s total time up to October 1939 was 280 hours 19 minutes with 202 take-offs. Of these 53 were performance flights. To

acknowledge the successes of this glider the Transportation Museum exhibited the *Karakán* in the great vaulted hall of the Museum. Unfortunately the glider was destroyed together with the vault in 1944 when the Museum got a direct hit during an air raid.

Another *Karakán* had been built at the workshop of the MOVERO in Farkashegy (registered as HA-4012). Her test flights were done by Mátyás Bernard at April 29, 1935, in Mátyásföld airfield, and later was exhibited at the International Fair, Budapest. At July of 1936 she was loaned to the Icarus flying school located at Gödöllő to experiment with winch launching method. Here thermal flights launched by winch were performed. József Szőnyi broke the Hungarian altitude record with this glider at May 14, 1939, climbing to 2212 m altitude. Unfortunately her fate was not better then that of the first *Karakán*. At April 6, 1940, she was copmletely destroyed in a hangar fire at Farkashegy. Her total flight time was barely 28 hours 10 minutes. The insurance company paid 5000 pengő [Hungarian currency at that time - GF] to the Club.



Coordinates of F cross-section $\bar{f}$=0,08 $\bar{d}$=0,155 $\bar{x}_f$=0,375 $\bar{x}_d$=0,30

x	0	0,5	1,0	1,5	2,5	5	7,5	10	20	30	40	50	60	70	80	90	100
y_a	4,00	2,75	2,50	2,15	1,75	1,25	0,90	0,50	0,10	0	0,10	0,45	1,00	1,25	1,05	0,70	0
y_f	4,00	5,50	6,15	6,65	7,55	9,15	10,50	11,50	14,35	15,50	15,25	14,00	11,90	9,15	6,15	3,15	0

Fig. 21. General arrangemen*t*

One-seater performance glider with strutted high-wing.

The wings consisting of 3 m long rectangle form inner parts and trapezoid form outer panels with elliptical wingtips were connected to a 600 mm wide wing stub which was structurally integral part of the fuselage. The wings were supported by streamlined double V-form struts which were connected to junction points located at the lower part of the fuselage. The ailerons run from the strut connections nearly to the wingtips. Looking back now they seem to be quite large.

The comfortable cockpit's celluloid covered canopy could have been released with one movement in case of emergency. Though the view through the celluloid panels were quite good forward as well as to sideways two big round openings were located on both sides at the pilot's head. In this way the ventilation of the closed cockpit was good, and if the pilot leaned to side it was even possible to see a bit backwards as well.

The upper part of the fuselage's structure in the vicinity of the wing roots had a rounded off transitional form up to the center wing root's integral structure. Behind the wing's trailing edges the cross section of the fuselage was reduced. Under the fin a strengthened keel extended downwards which served as tail skid. The Rotter designed release hook was fitted into the lower part of the nose (for its description see the *Nemere* section). Starting just behind it back to the line of the wing leading edge run the skid fitted with two-two rubber rings as springs. To reduce the drag the gaps between the fuselage and the skid were covered on both sides with leather.

The width of the fuselage is 550 mm at the cockpit. The available space was not reduced at the shoulder, elbow and hip of the pilot because of the distribution of structural items. The seat was upholstered. The backseat was an aluminium box open in front and above which served as the case for the parachute. Under the seat in the bottom there were space to keep essential provisions - foodstuff and cloth - for distance flights.

The hole for the cockpit on the fuselage was strengthened by a wooden panel which was coated by leather and served as a table on which the pilot was able to draw maps or make notes during the flight. The instruments (airspeed indicator with the Pitot-tube, vertical speed indicator with vacuum flasks, compass, artificial horizon with the Venturi-tube and a clock) were fitted into an instrument panel which was fastened to the removable canopy.

In the cockpit the traditional controls were fitted: joystick and the so-called sandal-pedals with bottom bearings for rudder control. The towing hook could have been activated by a ring on the right side. At the end of the *Karakán'*s fuselage a release mechanism for bungee-cord launches was fitted. The glider could have been fixed by ths mechanism for the duration of stressing of the bungee-cord to a "launch-rod" drived into the earth. The release of mechanism was controlled by the pilot from the cockpit via puling a ring located on the left side.

The leading edges of the tail surfaces were straight and their trailing edge contours were elliptic. The rudder was aerodynamically balanced, the elevator was of all-moving type.

Main data

Span 20 m. Wing area 20,70 m^2. Aspect ratio 19,40. Length of the fuselage 7,97 m. Empty mass 217 kg, take-off mass 297 kg. Wing load 14,40 kg/m^2. Best L/D cca. 22, minimum sinking speed: 0,6...0,65 m/s.

The *Karakán* was suitable for bungee-cord, winch and aerotow launchings. Basic aerobatics and cloud flying were permitted.

Aerodynamic characteristics

The most evident way to get small sinking speed and good gliding angle is to select high aspect ratio for the wing. This was the reason why Rotter had selected in the case of

Karakán, which was one of the biggest among contemporary gliders, 20 m span and nearly 20 value for aspect ratio. The chord of the rectangle form wing inner part was h_{root}=1,45 m, at the end of the wing outer panels the chord was h_{tip}=0,3 m. In this way the trapezoid ratio on the panels was $h_{root}t/h_{tip}$=0,207. The wing's aerodinamic center line was sweepless, the dihedral was 1°.

As was mentioned before Rotter created a completely new airfoil for the *Karakán*. The original darwing did not survive, however the 21. figure shows the reconstructed outline of the root airfoil based on pictures of the wing root. The relative thickness was 15,5%, the camber of the center line was 8%, and the location of maximal thickness was at the 30% of the chord. This airfoil run from the wing root to the inner end of the ailerons. From this point to outward this airfoil gradually was transformed to an airfoil having smaller camber and thickness. According to the designer's note on the outer parts of the wing -1,5° aerodynamic washout was used.

Because of the transition from slope soaring to thermal distance soaring designers took pains over ensuring effective control, especially to enhance the maneuverability for circling in thermals. However the high-wing arrangment as well as the great span support greater lateral stability. Namely if the pilot banks the glider in a turn the lift distribution over the span is modified by the rolling movement and an aerodynamic dumping is created working against the rolling movement. This "roll-dumping" effect in steady flying conditions makes controlling easier, as helps lateral stability. However in the case of circling in thermals this characteristic is disavantegous as the speed to roll the glider into turning (the angular velocity of the roll) is decreased. The roll-dumping effect depends (among others) on the span as well. In the case of the *Karakán* the designer wanted to counterbalance these disadventageous chracteristics with ailerons having - in present day valuation - quite large surfaces. Their length run on the 65% of the span, and their total area was 15,5% of the wing. Moreover the effectiveness of the ailerons were increased by a celluloid band on the bottom side closing the gap between the auxiliary spar and the ailerons - to prevent the equalization of the pressure on the upper and under side of the wing.

The crossection of contemporary advanced gliders had elliptic or standing egg form around the cockpit. The reason for the pointed lentil fuselage crosssection of the *Karakán* was given by Rotter that this solution produces smaller drag with big as well as small angle of attack flights, compared to the traditional non sharp crossection forms.

The side of fuselages similar to that of the *Karakán* were at small angles to the lower plane of the wing, and this were disadvantageous from the point of view of interference drag. So the designer of the *Karakán* used curved transitional surfaces with big radius and a pointed plate extending beyond the trailing edge of the wing which ensured an advantageous airstream (Fig. 22a). Intereference-drag is not confined to the wing-fuselage transition alone, however appears at any place where surfaces in the vicinity of each-other close down the speed of the airstream. Such places are the connections of the struts to the wing and to the fuselage. For this reason we would find in such places "ichthyold" form covers to ensure more advantageous transition surfaces.

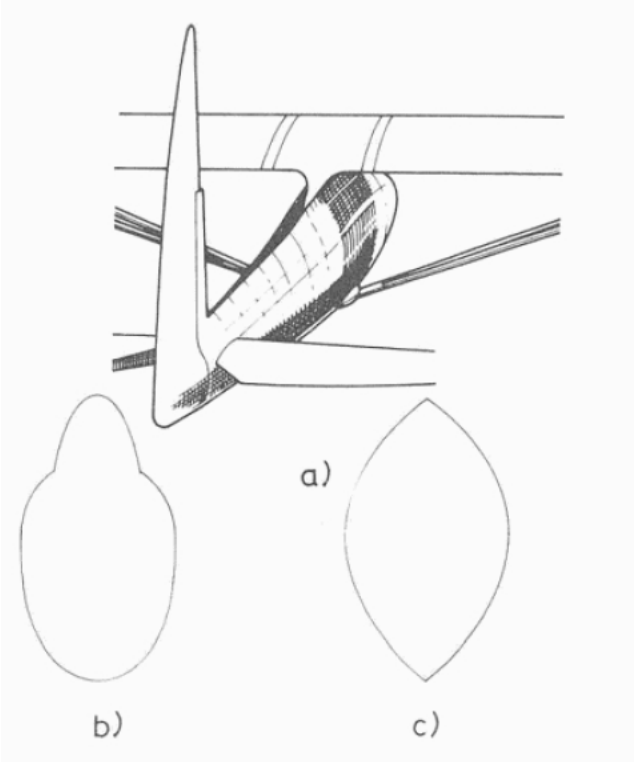


Fig. 22.

a) The wing-fuselage transition of the *Karakán*; *b)* the *Fafni*r, *c)* the *Karakán* fuselage nose cross section

The first glider with a complately closed cockpit was the *Fafnir*, however its canopy was not made of a transparent material but was covered with plywood. The pilot was only able to view out via the two openings cut on the plywood at both sides of the pilot's head (Fig.17). To let the pilot view a bit forward as well the canopy on the top of the nose part of the fuselage was formed as a narrow spine. (Similar was the fusalege nose of the 1934 world-recorder DuPont *Albatros* as well.) However this solution was not imperfect only because of the very limited pilot's view but was imperfect because of the eddies separated from the very sharp transition between the top of the fuselage and the spine, which increased the drag (Fig. 22b). The Karakán was among the firsts of world' gliders having had a compately closed cockpit. The form of its fuselage's nose was "adapted to the airstream" that is the airstream run backwards whithout separation and the distribution of the pressure was shaped advantageously from the point of view of the drag. All of this was possible because of the usage of a transparent canopy (Fig. 22c).

The reader may come to the interesting discovery in the later part of this book, that this fuselage nose form, which is generally used on present day gliders, was used with a few exceptions on all Hungarian high performance gliders, but which was very rarely used up to the 1960s on gliders designed abroad,.

The structure

The *Karakán* was a wooden glider covered with fabric.

The wing had a single main spar with an auxiliary spar running in the rectangle inner parts paralelly whith the trailing edge at the 75% of the chord length and in the outer wing parts running in the front of the ailerons. Altogether 132 lattice structured wing rib were “stringed” on to the main spar having a maximum height 207 mm and on to the auxiliary spar, that is the slats providing the rib contours in front of as well as behind the main spar were built from one piece and run on the total length of the chord. In this way the height of the main spar was lesser then that of the airfoil and for this reason the gap between the end of the contour slats “fill-up” slats were used. The nose part of the ribs back to the main spar was covered with plywood to create a box capable to take up torsional loads. At the root behind the leading edge a 1m long auxiliary spar was fitted on each sides to transmit the torsional momentum to the fuselage.

The fittings of the three wing spars were connected to the fittings on the fuselage with one-one bolts having had the same axis. This common axis of the bolts guaranteed that elastic deformations appearing in flight could not caused harmful stresses in the fuselage.

The main and auxiliary spars had box structures made of spruce caps and plywood webs.

The wings were covered with fabric varnished and cellon coated three times. The gap between the wing root and the wing stub was covered by a celluloid band which was fixed by running in grooves. Through this transparent band the wing as well as control surface mechanism connections could be easily inspected.

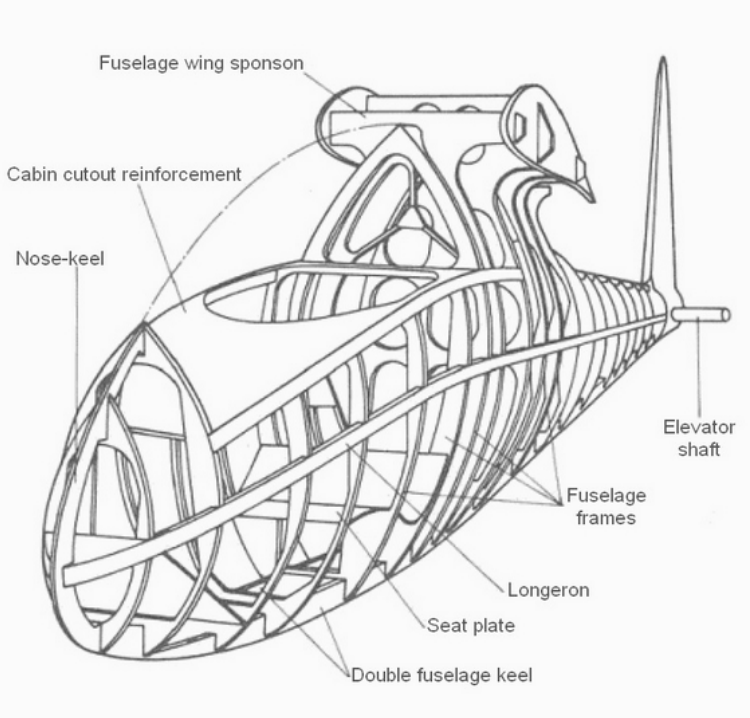


Fig. 23. The *Karakán* fuselage structure (1933)

The plywood covered monocoque fuselage with top and bottom sharp pointed crossection had the advantageous characteristics that landing on rough ground only the bottom edge, strengthened with a strong keel, would touch it. Potruding stones would not be able to cause serious damages. To protect the pilot in case of a mishandled landing the fore part

of the fuselage had also a strong structure. The bottom keel which run back to the end of the skid was a double keel, and from the main fuselage frame two auxiliary longerons run forward to the nose taking up the load from the wing connections. These strengthened the cockpit cut-out as well, and at the same time constituted the fladge of the cockpit's opening. The upper, horizontal level of the fledge back to the seat opening was covered with plywood (Fig. 23).

The torsional resistance of the fuselage was increased by the last fuselage frame in the vicinity of the symmetry plane had a hump. This frame at the same time served as the main spar of the vertical tail surface. The rudder was connected to this fuselage frame by four bearings. The rudder was covered by plywood in front of the rudder's main spar. Its other parts were covered by fabric.

On the 20 m span wings in case of cantilever arrangement the bending momentums would have been too large. The struts, fitted to spare mass and for easy production, were connected to the main spars at 3-3 m from the symmetry plane. They were connected to the fuselage at the main fuselage frame's lowest point. In this way the forces appearing in the struts remained in a closed, statically determined system. The fittings of the struts were fixed to the double keel at the bottom of the fuselage, and supported the load dumping rubber rings of the skid under the pilot's seat. At landing the rubber rings were loaded by the mass of the wing and the load on the fuselage was not increased.

The controls of the *Karakán* were moved via steel wire ropes. On the controls rope-segments were fitted and the control ropes rolled on these without slacking. That is the tightness of the ropes were even and as controls were fitted with roller-bearings the pilot was able to move them easily and smoothly. In the activate mechanism of the ailerons there was no wire-ropes running from the fuselage to the wings. The bell-cranks located on the main fuselage frame and behind the wing's main spar were connected by short pushing rods. In this way when disassembling the glider it was not necessary to unfasten wire-ropes and after disassembling everything remained in correct position and tight, as only one bolt on the short pushing rod had to be removed.

The long ailerons were connected by ten bearings and every aileron were moved by two, rods fitted with cable-segments. From the double cable segments of the bell-cranks in the wing root to the aileron moving rods separate cable pair run. This solution secured a better aileron load distribution.