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A REVIEW STUDY ON SUPER SONIC FLIGHT

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Abstract— The main aim of this topic is to give a review of the first and foremost supersonic passenger aircraft, its best aerodynamic designing and shape, one of the worst structures used in that, the continuous failures it got during its flight. This review will also mention its brief history and the reasons behind the failure of one of the great and unique design and the advantages that we can get if we remake it. This is one of the airplanes which are getting forgotten by aviation industry named Tupolev Tu-144.

Keywords- **Supersonic, Tupolev Tu-144, Aerodynamics, Braking Parachute, Paris crash**

I. INTRODUCTION

Now-a-days we are much developed in air transport and we are casual with supersonic passenger aircrafts to largest cargo flights with much better engines. Humans are much fascinated by speed, and the civil aviation industry is no different. A lots of efforts have been invested in the past to come up with the fastest passenger aircraft in the world, and we have witnessed the dreams of supersonic passenger aircrafts came true. Whenever we are thinking about first supersonic passenger aircraft then Concorde is the aircraft which we will get to remember immediately. But it certainly wasn't the first commercial plane which breaks the sound barrier.

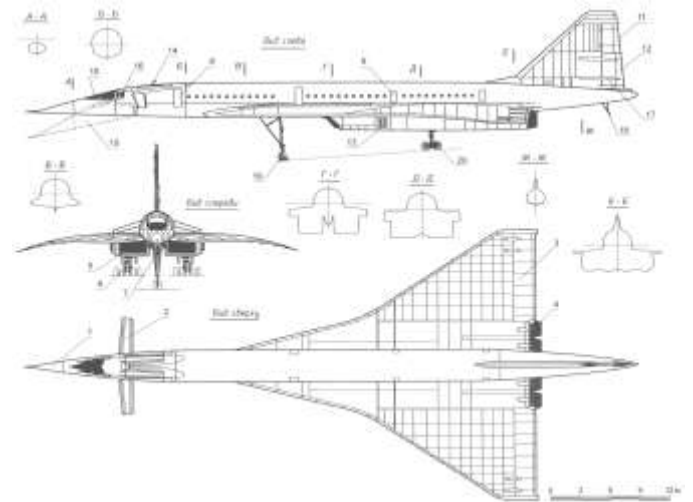


That honour belongs to Concorde's Soviet Older sister which we will see in further discussion. Everything needs an initiative. The first supersonic commercial vehicle too wants to have an initiative in the name of Concorde. But because of Russians cunningness supersonic commercial flights had a start-up with the name of Tupolev Tu-144. During the development of Concorde, Russians don't want the French and British government to get more advanced than them. So with the help of USSR spy they got the blueprints of Concorde but not completely. Anyhow the task to build the first supersonic

passenger aircraft was given to chief designer Andrei Tupolev under the management of soviet Tupolev design bureau. He too took the task with his team and completed the task in half successful manner. We can see why its half successful and if it became successful what great things may happened and a lot more unique qualities of Tupolev Tu-144 including its excellent aerodynamic shape, structure and propulsion based weakness and much more in the following review.

II. BASIC DESIGN

Mainly, Tupolev Tu-144 was based on Concorde's design but due to lack of full blueprint it got some unique design. Not only because of blueprint but also because of lack of Russian technology to bring the required outcome made TU-144 different from Concorde. Even after this we can say Tupolev



Tu-144 is an exact copy of Concorde except some measurements, materials used which even includes screws and bolts. Russians cunningness hasn't got much success because they can't get the proper wing shape like Concorde, which results in lack of required lift and stability. Then immediately a unique but more useful idea was implemented, that is they placed canard foreplanes just after the cockpit which helps in increasing lift at lower speeds. It too had a retractable nose and the canard is also made to be retractable with retractable flaps. Thus not only nose and canard gave difference between Tupolev Tu-144 and Concorde but Tupolev Tu-144 is bigger than Concorde. Everybody says Tu-144 resembles Concorde but there are a lots and lots of difference between them. Tu-



144 is the first prototype to have crew ejection



seats. It's the last commercial aircraft with brake parachute.

III. SUPERIOR AERODYNAMICS

Tupolev Tu-144 is a half successful and half failure first supersonic passenger aircraft. Behind its failure it was made into a successful and historical flight solely with its superior aerodynamics. In this aircraft each and every part, from wing to nose and from fuselage to vertical stabilizer, it possesses perfect aerodynamic shape which results in drag reduction. In its aerodynamic design we can say the placement of moustache canard is a marvel in engineering. They initially planned to mount a normal wing with a horizontal stabilizer which decreases Tu-144's aerodynamic efficiency. So they decided to install an ogival delta wing which provided more lift



as well as more aerodynamic efficiency. This wing is so thin so that it produces more lift at less speed which makes landing very tricky. Basically delta wings possess elevons. The major drawback of elevons is when it is lowered down in a delta-wing aircraft it increases lift as well as it pitches down the nose. This major drawback was cleverly solved by placing a moustache canard just after the cockpit. This represents Russian Chief Designer Andrei Tupolev's aerodynamic talent on those very early days of supersonic commercial aircraft development. Tupolev possesses superior aerodynamics compared to Concorde which makes it to have more payload area and its size also increased to an extent. Its nose which is retractable that is which can be drooped down was useful in getting clear view during takeoff and landing.

IV. STRUCTURE AND COOLING SYSTEMS

The great defect came for Tu-144 following the weak structure formation. The designer gave more importance to aerodynamics to make it superior but failed to make a good structure. After the weak structure it possesses, it also had no better cooling system. They designed the cooling system to be air flow based but not liquid based. This caused a great noise inside the cabin. That noise even hasn't allowed the nearby passengers to have vocal conversation which resulted in passing messages using paper.

V. PROPULSION

Like structure, Russians don't have a proper propulsion system too at that time. Their only hope which gave the required thrust for Tu-144 is afterburning Kuznetsov NK-144 turbofan engine but without good efficiency. NK-144's high specific fuel consumption gave a limited range of 2,500 kms with a max speed of 2,430 Km/h along with the afterburner. This range is far less than Concorde. So they started to develop a



non afterburning turbojet, Kolesov RD-36-51A. In further development of Tu-144D used Kolesov RD-36-51 which acquired the required SFC and the range with full payload increased to 5,330 Km/h. Without afterburner there were no proper nozzles available for supersonic engines. So they used translating plug nozzle.

VI. GENERAL CHARACTERISTICS

Crew:	3
Capacity:	120-140 Passengers
Length:	65.50 m
Wingspan:	28.80 m
Height:	10.50 m
Wing Area:	438.0 m ²
Empty Weight:	85,000 Kg
Max takeoff weight :	180,000 Kg
Fuel Capacity:	70,000 Kg
Maximum Speed:	2,500 Km/h / Mach - 2.35
Cruise Speed:	2,300 Km/h / Mach - 2.16

Practical range of aircraft according to Payload:
 7 Tons (70 Pass) - 6,200 Kms
 11 to 13 Tons (120 Pass) - 5,500 Kms
 15 Tons (150 Pass) - 5,330 Kms

VII. PRODUCTION

The Tupolev Tu-144 is not a single aircraft but it had its own family not only one or two, they were 16.5 total aircrafts of 5 types. Here 16.5 is mentioned because their family had a last family member which is incomplete.

Their types are as follows

- The prototype Tu-144 - Hero of this review
- Pre-production Tu-144S
- Nine production Tu-144S - With less efficient afterburning turbofan engine
- Five Tu-144D models - With greater efficient newly developed turbojet engine
- Last one which is mentioned as half in the statement above is Tu-144D which remained incomplete.

VIII. OPERATIONAL SERVICE

First historical SST came out to fly on last day of 1968 and made an impact in Civil Aviation, two months before Concorde. Tu-144 flew with supersonic speed by 1969. By 1970 it became the first commercial aircraft to exceed Mach 2. From 1975 Tu-144 started its mail service as a preparation for commercial aircraft. Then it acted as supersonic passenger aircraft from 1977 to 1978 in which 55 scheduled flights had been completed. Then it was used for research purpose only and it was totally left by 1999.

IX. REASONS FOR FAILURE

Its failure started from the Paris Air show during 1973 where a terrible crash of Tu-144 took place which ended in killing 6 crew members and 8 civilians and destroying 15 houses too. The reason behind this crash is due to a French aircraft named Mirage which involved in taking photography at 4000ft without proper information given to the crew members of Tupolev Tu-144. The graph of this incident is shown below. Due to this a low pass was made over runway 06 to avoid direct crash. At the end of the runway the aircraft entered a steep climb. While the canards on the forward fuselage were being retracted, the Tu-144 entered a



steep dive. The disturbed airflow may have caused one or more engines to flame out. In order to regain control the canards were deployed again. The crew tried to pull out of the dive, causing the overstressing of the airframe. The left canard-wing is reported to have separated, striking the wing and puncturing the fuel tank. The Tupolev broke up and crashed in flames into the small town of Goussainville. It appears that, for safety reasons, the Tupolev factory had restricted the control surface deflection to a maximum of 5 degrees with canards extended. There are more factors such as

- Airframe Structure Failure,
- Cabin Noise,
- Compressor disc failure and
- Economic Inefficiency.

After all this the whole capacity (120 to 140 Pass) is not fulfilled. Only 50 to 60 passengers were allowed to travel during every scheduled flight to ensure passenger safety. Cabin noise will start from the start of the flight up to landing mainly due to cooling system based on air.

X. FUTURE DEVELOPMENT

As mentioned earlier Tupolev Tu-144's superior aerodynamics, retractable nose and moustache canard can give a great future SST. By implementing the present propulsion system we can achieve good speed with higher efficiency and



because of presence of more advanced and stronger alloys the structural problems can be resolved. During Tu-144's first flight the crew given a statement mentioning "It's easy and smooth to control this newly developed SST". So by doing



some little changes we can make the first supersonic passenger aircraft to be easier to use as well as introducing Tu-144 with certain changes will provide a great impact in civil aviation. For our present faster and competitive world new refurbished Tupolev Tu-144 with turbojet engines will act as most efficient and useful transporter. But Russian military is using the engine used in Tupolev Tu-144 and the Russian government is refusing to sell Tu-144D.

XI. CONCLUSION

Very few modern birds came with a great story and Tupolev Tu-144 is one which boosted the aviation industry's development. So we should not leave that superior aerodynamic quality to get devastated and this is the aircraft which possess 2+2 jet engines very closer. We should try to refurbish this aircraft in future so that the travelling will get faster and safer with higher efficiency.

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