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SIGNIFICANT OF LOADING PERFORMANCE ON SUKHOI – 37

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ABSTRACT

In the paper to determination of significant loading together with the calculation of static strength in addition to fatigue through performance for all significant structural components is a main prerequisite for successful design and safe operation of Sukhoi – 37 fighter aircraft. The loads estimation needs to feasible on speed of aircraft, altitude, payload, airplane gross weight, engine thrust, flap angle ,aircraft center of gravity, fuel quantities, with airbrake position for every of the necessary maneuver and load cases for every a part of the aircraft. The aim of this significant loading performance to develop methods for load analysis in a fast and integrated way during theoretical and beginning design phases, then to perform a load analysis of an Sukhoi – 37 fighter aircraft as a calculate for the demonstration of the loading performance process.

Keywords: Aircraft loads, Structural analysis, Operation of Sukhoi – 37 fighter aircraft, Aerodynamic models, Maneuver analysis, Aero elastic

I. INTRODUCTION

The developed project design is critical loading performance process, to develop methods for simplification of aircraft Sukhoi – 37 the 'conceptual design study' layouts are technically feasible and commercially viable at the start of the phase all options are considered during the concept design phase the quantity of data generated on each design in the relatively limited and the man power expended small. The outcome of study is the knowledge of the feasibility of the various concepts and an estimate of the rough size of the most likely configurations established by the prospective customer or a generated guess as what the future customer need.

The detailed this paper to calculate all types of loading analysis. In this part of the calculation process the layout is refined to a greater level of detail. In this phase, there will be an increasing reluctance to make radical geometric changes the overall layout of the aircraft. Throughout this phase, the aircraft load and performance estimate will be continuously updated as more details of the Sukhoi – 37 aircraft layout becomes available.

Therefore, it's miles clear that, designing the plane shape as light as possible is a critical objective for aircraft designers, for you to meet overall performance parameters set with the aid of the undertaking requirements. In other words, the aircraft structure must be light enough to meet design objectives, yet strong enough to endure the forces it experiences during its lifetime. Determination of those forces acting on the aircraft during, turbulence, maneuvers, landing and ground operations is defined as load estimation.

Fig 1: Sukhoi – 37

II. FIELD OF STUDY

A. Collar aero elastic triangle

Turbulence, maneuver, landing and ground loads arise from the interaction between elastic, aerodynamic forces and inertial, acting on the aircraft structure. This interaction on elastic of aerodynamic and inertial forces is defined as aero elasticity. Static aero elasticity, which deals with non-oscillatory interaction of elastic forces and aerodynamic on the however, aircraft structure is generally used in conjunction with static load analysis.

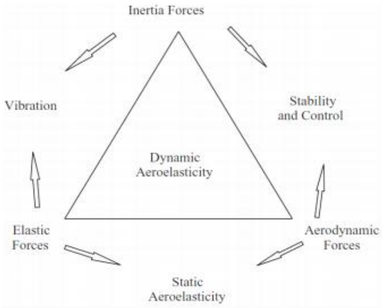

Fig 2: Collar Aero elastic Triangle

B. Loads Triangle

The load analysis refers to static load evaluation whereas dynamic load evaluation, which deals with flutter, limit cycle oscillations is beyond the scope of this study. The inertial forces are nonoscillatory and arise from the steady state gravitational acceleration acting on aircraft mass.

In conceptual design phase, estimation of structural weight to satisfy design objectives calls for the estimation of structural loads. Also, in preliminary evaluation, load analyses are completed for selection of simple structural layout. Finally, in special and certification phase, load analyses are accomplished with most detail with all modern day aerodynamic, inertia and stiffness properties obtained from other groups.

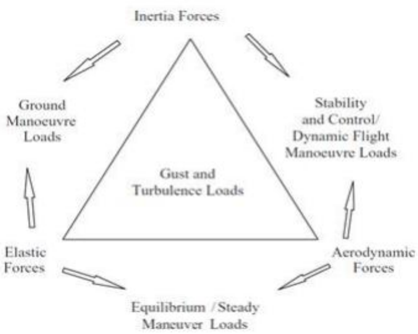

Fig 3: Loads Triangle

III. VELOCITY –LOAD FACTOR (V-N) ILLUSTRATION

The control of weight in aircraft design is of excessive significance. Excesses of structural weight imply lesser quantities of payload, thereby affecting the monetary viability of the plane. However, to ensure general minimal standards of electricity and protection, airworthiness policies (Av.P.970 and BCAR) lay down several factors which the primary shape of the plane must satisfy.

The elemental strength and combat performance limits in support of a specific aircraft are determined on by the airworthiness establishment and are restricted in the flight enveloper-n diagram.

Lift = n W = ½ ρ v² SCL max

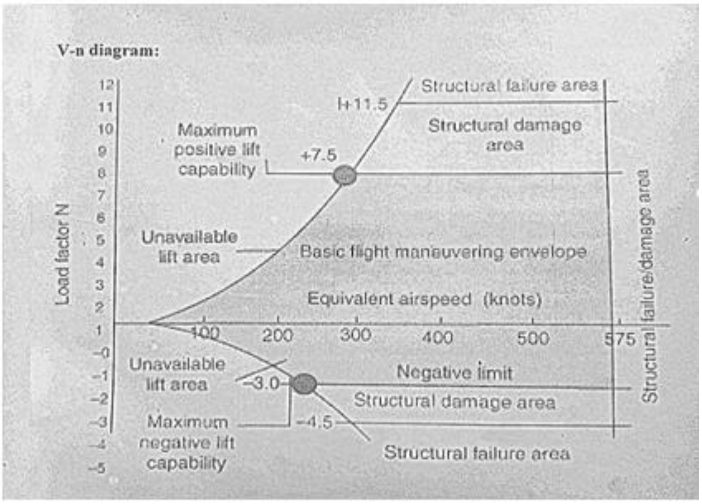

Fig 4: V-n illustration

Significant Velocities

The major velocities that r plotted in the V-n illustration are:

- 1 – g Stall speed
- Design Maneuvering speed
- Design Cruise speed
- Design Dive speed

Design stalls velocity (V_s)

$CN_{max} = 1.01\ CL_{max}$

$=1.01 * (1.2)$

$CN_{max} = 1.212$

$V_s = (2w/\rho\ CN_{max})^{1/2}$

$= 408.67$

Design boundary load factor [η_{lim} positive &negative]

$\eta_{lim} = 0.4\ \eta_{lim}$positive

$= 0.4 * (2.822)$

$= 1.1288$

η_{lim}positive $= 2.1 + 26000 / w + 10000$

$= 2.1 + 26000 / 26000 + 10000$

$= 2.8220$

Design cruising velocity (v_c)

$V_c = k_c\sqrt{w/s}$

= 33 (26000 /15.0)

= 91.509

Design maneuvering velocity (v_A)

$V_A = v_s \sqrt{\eta}$ lim positive

$= 14.852 \sqrt{2.822}$

= 23.92

Design Diving velocity (V_D)

$V_D = 1.4\, V_C$

= 1.4 * (91.59)

= 128.26

Load factor (η)

$\eta = L / W$

$= 1/2\, \rho v^2 S C L_{max} / W$

$= ½ (0.413*350^2*15*1.5)/26000$

= 21.89

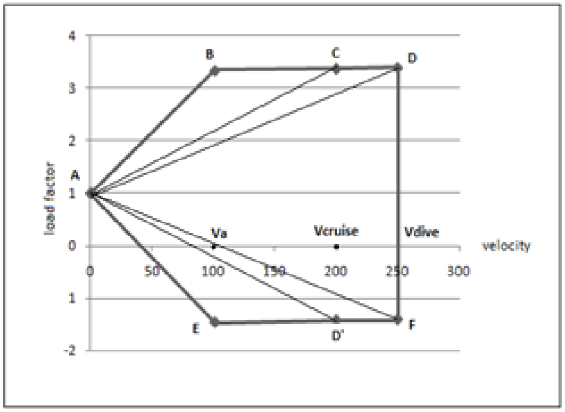

Fig 5: Gust V-n Diagram

IV. CRITICAL LOADING PERFORMANCE

The load factor for different maneuvers found out and load factor during critical performance like minimum turning radius, pull awake etc. to be found.

For Minimum whirling Radius,

$$R_{min} = \frac{4K \frac{W}{S}}{ge\frac{T}{W}\sqrt{1-4K\,CDo\,(T|W)^2}}$$

Where, $K = \frac{1}{\pi e AR}$, e = 0.81, AR = 9.16

$$K = \frac{1}{\pi \times 0.81 \times 9.16}$$

K = 0.0429

$\frac{W}{S} = \frac{26000}{15}$ = 650

$\frac{T}{W} = 0.97$

$L = \frac{1}{2}\rho v^2 S C_L$

$1584 = \frac{1}{2} \times 0.413 \times 650^2 \times 15 \times C_L$

$C_L = \frac{1584\times2}{0.413\times650\times650\times15} = 1.21\times10^{-3}$

$D = \frac{1}{2}\rho v^2 S C_D$

$3069 = \frac{1}{2}\times0.413\times 650^2\times15\times C_D$

$C_D = \frac{3069\times2}{0.413\times650\times650\times15} = 2.34\times10^{-3}$

$R_{min} = \frac{4\times0.0429\times650}{9.81\times0.81\times0.96\sqrt{1-4\times0.0429\times2.34\text{^}-3\times0.97\text{^}2}}$

$R_{min} = 14.62$

For Pull awake maneuver

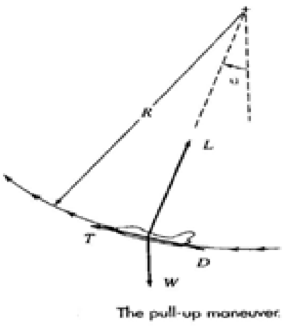

Fig 6: Pull awake maneuver

Load factor can be found from,

$R = \frac{V\text{^}2}{g(n-1)}$

$R = \frac{650\text{^}2}{9.81(3.878-1)} = 14964$

For Pull behind maneuver

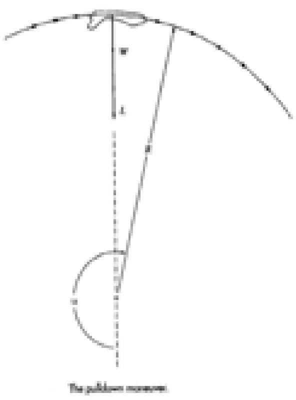

Fig 7: Pull behind maneuver

Load cause can be established,

$R = \frac{V\text{^}2}{g(n+1)}$

$R = \frac{650\text{^}2}{9.81(3.888+1)} = 8829$

For Rate of Glide,

$R/S = \sqrt{\frac{W}{\frac{1}{2}\rho S}} \times \frac{CD}{(CL^2+CD^2)^1/2}$

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$$= 91.61 \times \frac{0.00234}{0.0643} = 634.83$$

V. RESULT AND DISCUSSION

The outcomes of the load analysis are particularly the load distribution along the additives. These distributions may be visualized via the masses envelopes, in particular 1D load envelopes. Loads envelopes are basically shear and moment diagrams which can be used for both the choice of the critical load cases and the assessment of critical loads. In the later tiers in layout, however, critical load cases are nevertheless decided on from the envelopes, whereas the load values are taken from specially 3-d analyses in keeping with critical load instances.

Table-1: Structural load intensity and lift load intensity

Span	chord	Lift load intensity	Lift on element	Structural load intensity	Resultant load intensity
0	1.73	243.25	17.02	18.88	57.85
3	1.66	233.40	49.01	17.38	31.63
6	1.45	203.88	42.81	13.26	29.55
9	0.99	139.20	64.03	6.18	1.86
11	0	0	0	0	0

Resultant Load Intensity = Structural Load Intensity – Lift Load Intensity

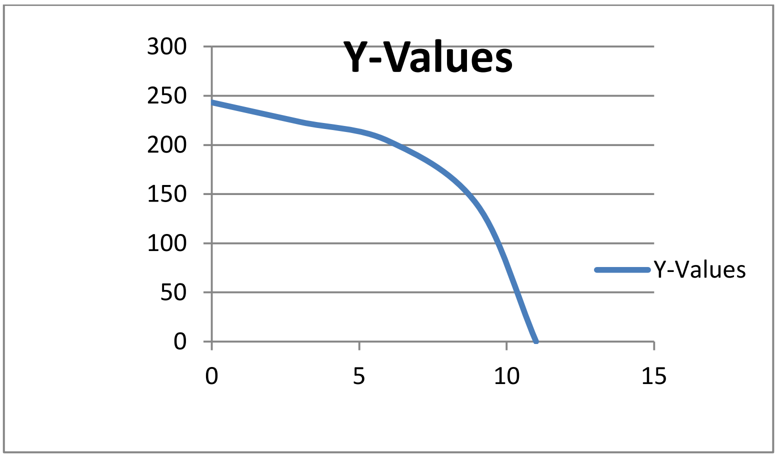

Fig 8: Lift Load Vs Span

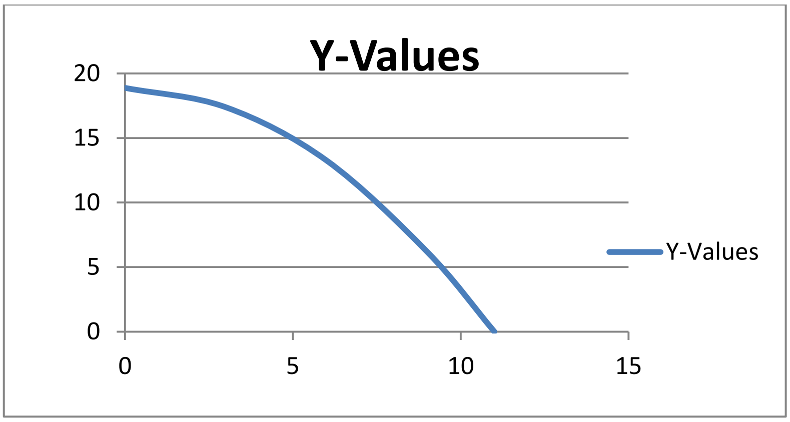

Fig 9: Structural Load Vs Span

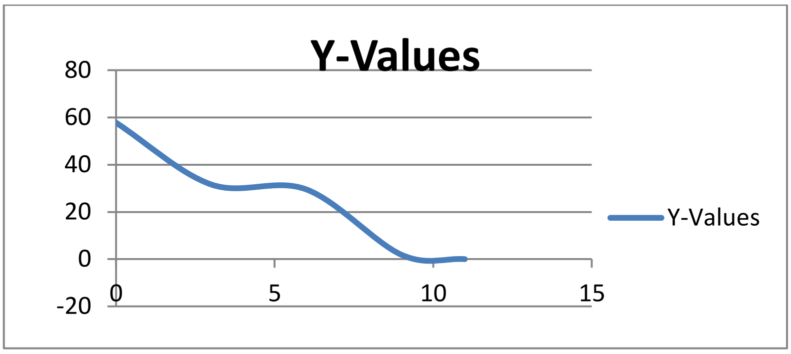

Fig 10: Load Intensity Vs Span

From the above graphs, it can be inferred that all the three parameter decrease the measurement lengthwise of the span of the wing.

VI. CONCLUSION

In this thesis paper, the aircraft load analysis procedure is detailed; the methods for simplification of loads input are discussed. Specially, in the load analysis procedure, the utilize of simplify aerodynamic and structural models is emphasized. With the load cases being generated to cover all of flight regime of the aircraft, the calculation of loads are performed for each case in an automated process. The calculation is performed in a straightforward approach by integration of loads along the aircraft components using the analytical formulae derived in the simplification of aerodynamic model.

After the calculation of loads, load envelopes are prepared and most critical load cases are selected. The load envelopes are generated to visualize the load distributions along the primary aircraft components. Those envelopes enable the selection of critical load cases the same as the estimate of the significant loads performing on the aircraft structure throughout flight.

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