Rotor 15

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Original model

Rotor 15 is a fan which was the first of a series of designs in support of NASA’s low-noise conventional aircraft engine program. The fan designed in this program have unconventional geometric and aerodynamic features because of noise considerations.

- Original technical report [(cite:gelder74design>Gelder. «Aerodynamic performance of 0.5-meter-diameter, 337-meter-per-second tip speed, 1.5-pressure-ratio, single-stage fan designed for low noise aircraft engines » 1974. pdf)]:

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@TechReport{gelder74design,
author      = {Gelder, Thomas F. and Lewis, George W.},
title       = {Aerodynamic performance of 0.5-meter-diameter, 337-meter-
per-second tip speed, 1.5-pressure-ratio, single-stage fan designed for
low noise aircraft engines},
institution = {NASA Lewis Research Center Cleveland, OH, United States},
note        = {NASA-TN D-7836, url~:
\url{https://ntrs.nasa.gov/citations/19750006695}, 1974}}
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- Picture :

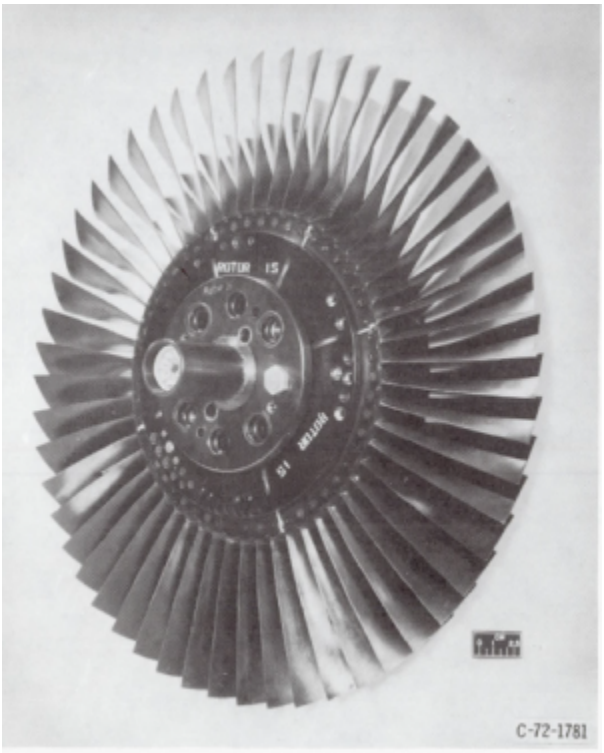


Fig1. https://ntrs.nasa.gov/citations/19750006695 p.153

Useful documents

- PDF of the NASA report : rotor15.pdf
- CSV file of the blade geometry : rotor15_original.csv

Geometry

The geometry of rotor 15 is described in the original NASA report by the following tables. The length are in centimeters and the angles in degrees.

TABLE IV. - BLADE GEOMETRY FOR ROTOR 15

RP	PERCENT SPAN	RADII RI	RADII RO	BLADE ANGLES KIC	BLADE ANGLES KTC	BLADE ANGLES KOC	DELTA INC	CONE ANGLE
TIP	0.	24.750	23.962	60.18	56.04	37.62	3.32	-20.375
1	5.	24.132	23.424	58.16	53.63	37.89	3.37	-17.428
2	10.	23.510	22.886	56.33	51.57	37.68	3.46	-14.752
3	15.	22.884	22.347	54.69	49.88	37.00	3.58	-12.262
4	30.	21.021	20.732	50.52	45.02	31.80	4.17	-5.998
5	50.	18.560	18.579	45.41	38.87	20.63	5.49	0.349
6	70.	16.075	16.425	39.39	32.45	4.28	7.78	5.833
7	85.	14.192	14.810	33.67	27.61	-11.12	10.32	9.632
8	90.	13.573	14.272	31.22	26.10	-16.53	11.60	10.738
9	95.	12.960	13.734	28.47	24.63	-22.01	13.13	11.756
HUB	100.	12.352	13.195	25.42	23.22	-27.59	14.88	12.727

RP	BLADE THICKNESSES TI	TM	TO	AXIAL DIMENSIONS ZIC	ZMC	ZTC	ZOC
TIP	0.036	0.143	0.032	0.711	1.655	1.926	2.831
1	0.036	0.145	0.031	0.666	1.683	1.914	2.920
2	0.037	0.147	0.032	0.620	1.700	1.886	2.990
3	0.038	0.151	0.032	0.573	1.706	1.841	3.042
4	0.042	0.167	0.034	0.448	1.673	1.674	3.196
5	0.050	0.199	0.038	0.313	1.624	1.408	3.407
6	0.062	0.246	0.045	0.203	1.625	1.114	3.638
7	0.074	0.295	0.052	0.082	1.631	0.825	3.723
8	0.079	0.315	0.055	0.048	1.637	0.731	3.734
9	0.084	0.337	0.058	0.022	1.648	0.641	3.738
HUB	0.090	0.360	0.061	0.000	1.664	0.554	3.734

Aerodynamic design

	unit	values
pressure ratio	[-]	1.5
mass flow	[kg/s]	29.16
tip speed	[m/s]	337
tip solidity	[-]	1.344
aspect ratio	[-]	3
number of blades	[-]	53
rotative speed	[rad/s]	1363.45

Material properties

The original material of the rotor 15 is not defined in the NASA report.

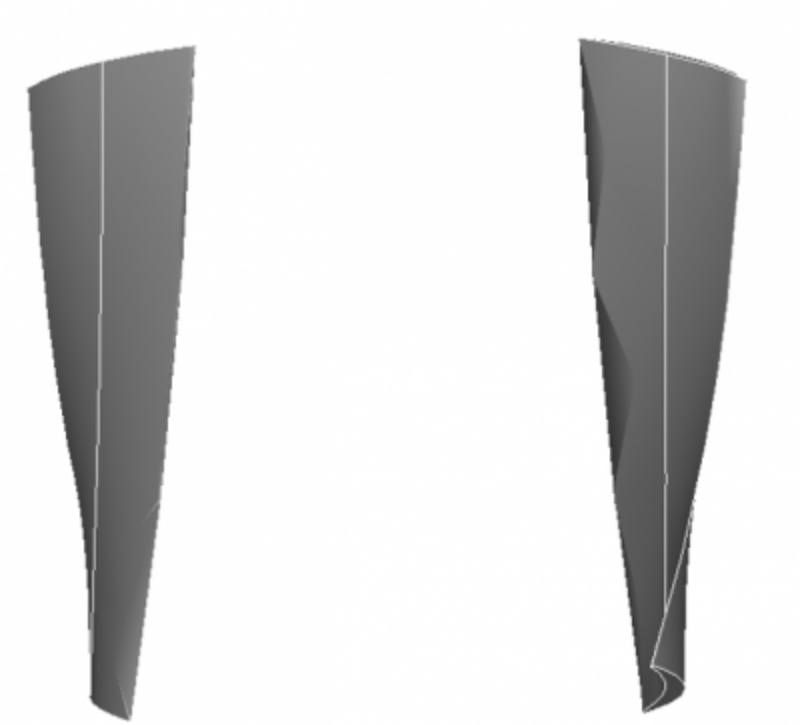
Considered properties: Ti-6Al-4V, generic titanium :

	unité	valeurs
alloy	[-]	Ti-6Al-4V
Young's modulus	[GPa]	108
density	[kg/m3]	4400
Poisson's ratio	[-]	0.34
yield stress	[GPa]	0.824

First three natural frequencies (with clamped root) for the mesh:

1. (1B): 1480.4 rad/s / 235.6 Hz
2. (2B): 4860.4 rad/s / 773.6 Hz
3. (1T): 8961.4 rad/s / 1426.2 Hz

CAD



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Modèle original

Le rotor 15 une la soufflante, qui a été le premier d'une série à l'appui du programme de la NASA pour des moteurs d'avion conventionnels à faible bruit. Les soufflantes conçus dans le cadre de ce programme présentent des caractéristiques géométriques et aérodynamiques non conventionnelles pour des raisons de réduction du bruit.

- Rapport technique original [(cite:gelder74design>Gelder. «Aerodynamic performance of 0.5-meter-diameter, 337-meter-per-second tip speed, 1.5-pressure-ratio, single-stage fan designed for low noise aircraft engines » 1974. pdf)]:

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- Photographie :

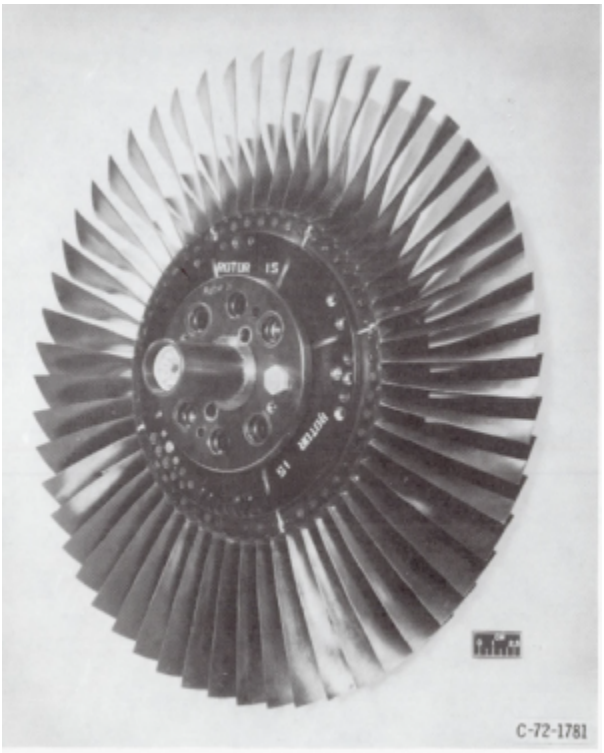


Fig1. https://ntrs.nasa.gov/citations/19750006695 p.153

Documents utiles

- PDF du rapport de la NASA : rotor15.pdf
- Fichier CSV de la géométrie : rotor15_original.csv

Géométrie

La géométrie du rotor 15 est décrite dans le rapport d'origine de la NASA par les tableaux suivants. Les grandeurs sont en centimètres et en degrés.

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RP	BLADE THICKNESSES TI	BLADE THICKNESSES TM	BLADE THICKNESSES TO	AXIAL DIMENSIONS ZIC	AXIAL DIMENSIONS ZMC	AXIAL DIMENSIONS ZTC	AXIAL DIMENSIONS ZOC
TIP	0.036	0.143	0.032	0.711	1.655	1.926	2.831
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HUB	0.090	0.360	0.061	0.000	1.664	0.554	3.734

Caractéristiques aérodynamiques

	unités	valeurs
taux de compression	[-]	1,5
débit massique	[kg/s]	29,16
vitesse en tête	[m/s]	337
solidité en tête	[-]	1,344
allongement	[-]	3
nombre d'aubes	[-]	53
vitesse de rotation	[rad/s]	1363,45

Propriétés matériau

Le matériau original du rotor 12 n'est pas défini dans le rapport de la NASA.

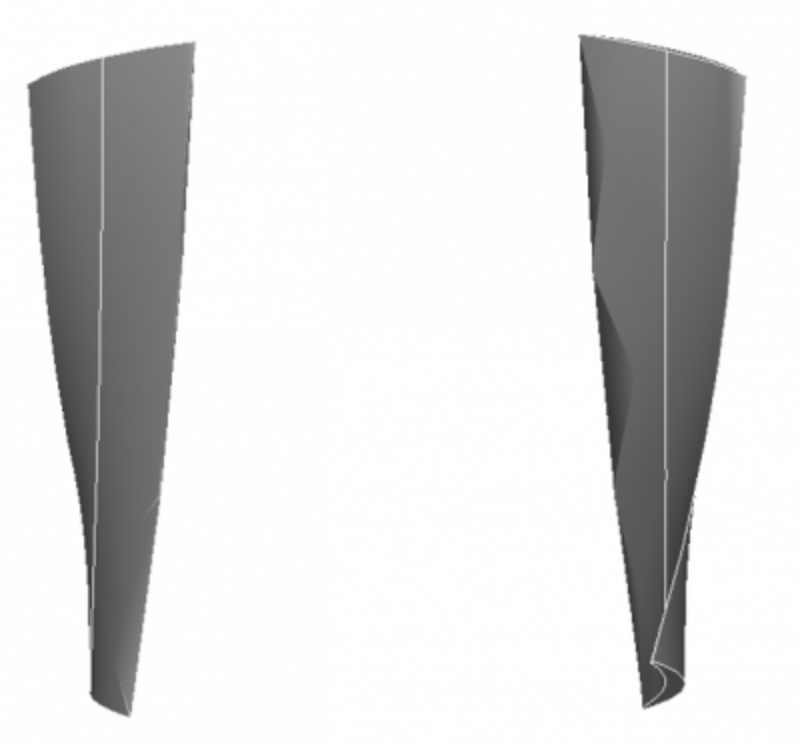
Propriétés considérées : alliage de titane Ti-6Al-4v :

	unité	valeurs
alliage	[-]	Ti-6Al-4v
module d'Young	[GPa]	108
masse volumique	[kg/m3]	4400
coefficient de Poisson	[-]	0,34
limite élastique	[GPa]	0,824

Fréquences des trois premiers modes (noeuds de la base encastrés) pour le maillage :

1. (1B): 1480,4 rad/s / 235,6 Hz
2. (2B): 4860,4 rad/s / 773,6 Hz
3. (1T): 8961,4 rad/s / 1426,2 Hz

CAO



Document issu de la page wiki:
https://wiki.lava.polymtl.ca/public/modeles/rotor_15/accueil?rev=1663351887

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