

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 ^[1]:

```
@TechReport{gelder1974design,
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}}
```

- Picture :

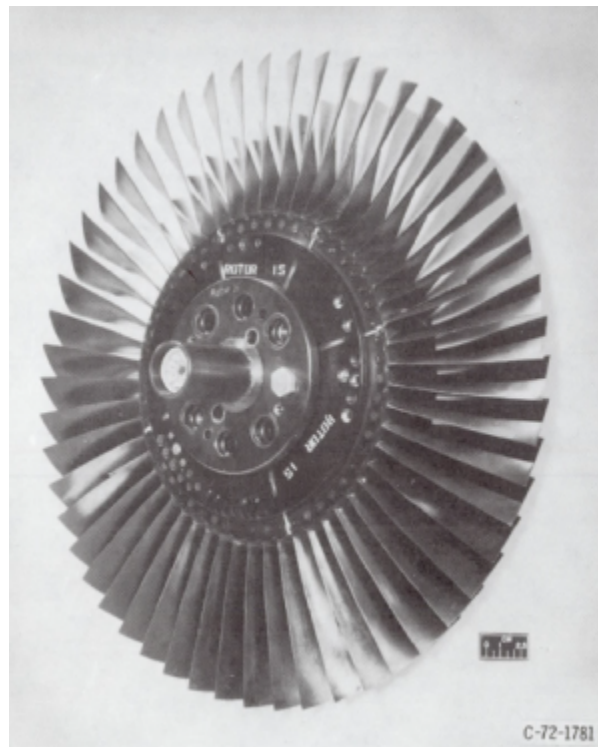


Fig1. <https://ntrs.nasa.gov/citations/19750006695> p.153

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 RADII			BLADE ANGLES			DELTA INC	CONE ANGLE
	SPAN	RI	RO	KIC	KTC	KOC		
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			AXIAL DIMENSIONS			
	TI	TM	TO	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.

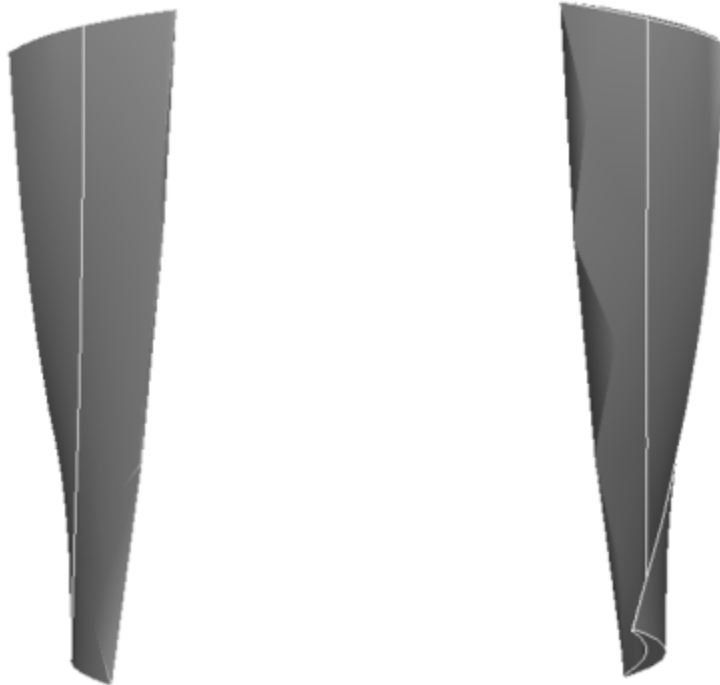
Considered properties: Ti-6Al-4V, generic titanium :

	unité	valeurs
alloy	[-]	Ti-6Al-4V
Young's modulus	[GPa]	108
density	[kg/m ³]	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 est 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](#) ^[1]:

```
@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  
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\url{https://ntrs.nasa.gov/citations/19750006695}, 1974}}
```

- Photographie :

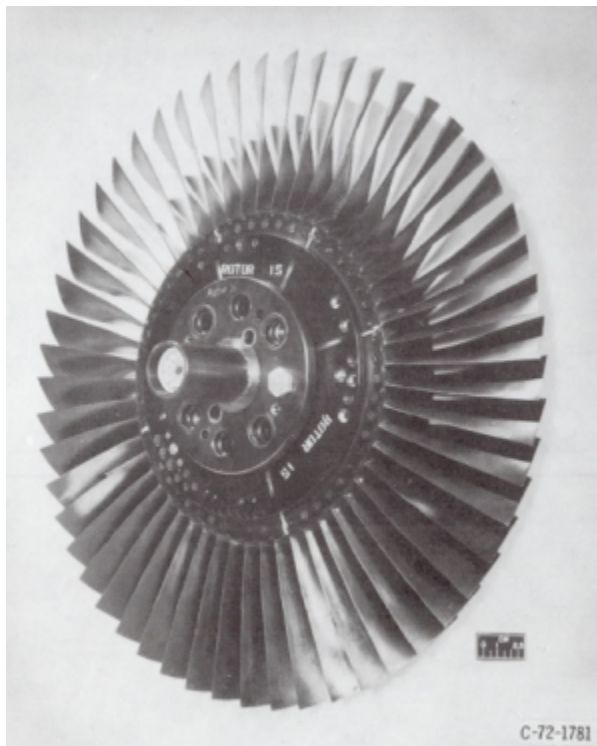


Fig1. <https://ntrs.nasa.gov/citations/19750006695> p.153

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.

TABLE IV. - BLADE GEOMETRY FOR ROTOR 15

RP	PERCENT RADII			BLADE ANGLES			DELTA CONE	
	SPAN	RI	RO	KIC	KTC	KOC	INC	ANGLE
TIP	0.	24.750	23.962	60.18	56.04	37.62	3.32	-20.375
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HUB	100.	12.352	13.195	25.42	23.22	-27.59	14.88	12.727

RP	BLADE THICKNESSES			AXIAL DIMENSIONS			
	Ti	Tm	To	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
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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

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.

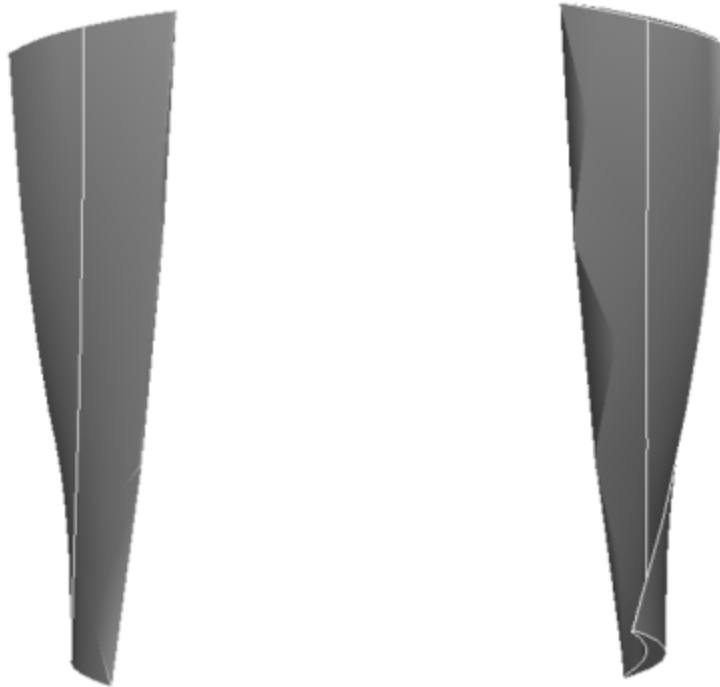
Propriétés considérées : alliage de titane Ti-6Al-4v :

	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 encastres) 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



1. ^{a, b} 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](#)

Document issu de la page wiki:

https://lava-wiki.meca.polymtl.ca/public/modeles/rotor_15/accueil?rev=1671384483

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