Rotor 7

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Original model

Rotor 7 is part of a research program to study the effects of blade shape on efficiency and stall margin. A series of transonic rotors, including rotor 6 and 7, were design with the same exit total pressure distribution to investigate the effects of blade shape.

- Original technical report [1]:

```
@TechReport{urasek1972design,
author      = {Urasek, Donald C. and Janetzke, David C.},
title       = {Performance of tandem-bladed transonic compressor rotor
with tip speed of 1375 feet per second},
institution = {NASA Lewis Research Center Cleveland, OH, United States},
note        = {NASA-TM X-2484, url~:
\url{https://ntrs.nasa.gov/citations/19720011123}, 1972 }}
```

- Picture :

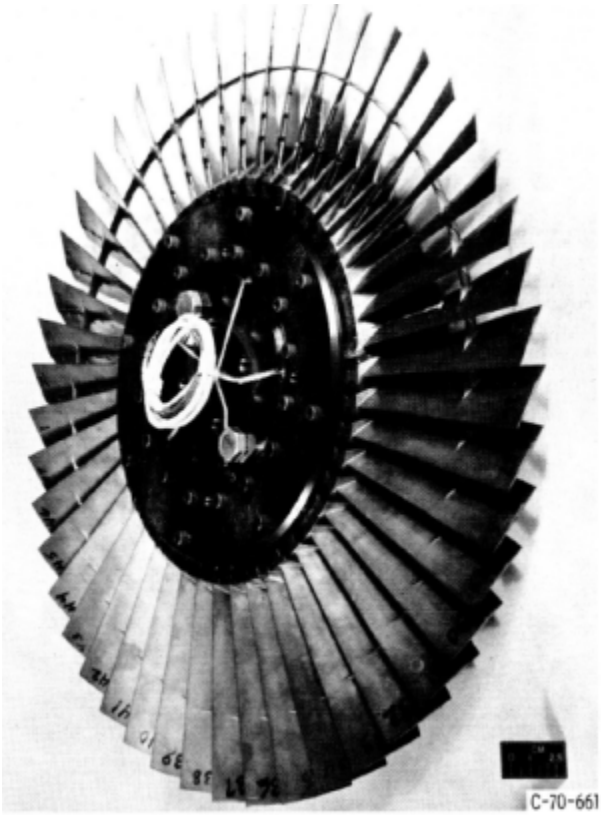


Fig1. https://ntrs.nasa.gov/citations/19720011123 p.58

Useful documents

- PDF of the NASA report : rotor7.pdf
- CSV file of the blade geometry : rotor7_original.csv

Geometry

The geometry of rotor 7 is described in the original NASA report by the following tables. The length are in inches and the angles in degrees.

TABLE III. - BLADE GEOMETRY FOR ROTOR 7

RP	PERCENT SPAN	RADII RI	RADII RO	BLADE ANGLES KIC	BLADE ANGLES KTC	BLADE ANGLES KOC	DELTA INC
TIP	0.	9.852	9.818	61.27	59.53	48.55	2.57
1	5.	9.717	9.623	60.39	58.83	48.51	2.75
2	10.	9.508	9.429	59.08	57.74	48.33	3.03
3	30.	8.635	8.650	54.43	53.07	45.16	4.18
4	40.	8.180	8.261	52.27	50.40	42.35	4.77
5	43.	8.065	8.164	51.75	49.69	41.52	4.91
6	45.	7.949	8.067	51.22	48.96	40.63	5.06
7	48.	7.832	7.969	50.70	48.23	39.71	5.21
8	50.	7.714	7.872	50.19	47.49	38.76	5.35
9	70.	6.726	7.094	46.38	41.40	29.63	6.46
10	90.	5.592	6.315	44.06	36.61	17.09	7.30
11	95.	5.266	6.121	43.89	36.11	13.27	7.42
HUB	100.	5.014	5.926	43.87	35.93	9.32	7.48

RP	BLADE THICKNESSES TI	BLADE THICKNESSES TM	BLADE THICKNESSES TO	AXIAL DIMENSIONS ZMC	AXIAL DIMENSIONS ZTC	AXIAL DIMENSIONS ZOC	CONE ANGLE
TIP	0.020	0.059	0.020	0.421	0.560	0.893	-2.181
1	0.020	0.061	0.020	0.432	0.561	0.922	-5.794
2	0.020	0.066	0.020	0.449	0.563	0.951	-4.776
3	0.020	0.083	0.020	0.509	0.551	1.069	0.842
4	0.020	0.092	0.020	0.538	0.535	1.132	4.083
5	0.020	0.094	0.020	0.545	0.530	1.148	4.922
6	0.020	0.096	0.020	0.552	0.524	1.165	5.771
7	0.020	0.099	0.020	0.560	0.518	1.181	6.638
8	0.020	0.101	0.020	0.567	0.512	1.197	7.520
9	0.020	0.120	0.020	0.624	0.445	1.328	15.492
10	0.020	0.142	0.020	0.669	0.351	1.438	26.702
11	0.020	0.148	0.020	0.676	0.324	1.459	30.363
HUB	0.020	0.153	0.020	0.680	0.302	1.477	31.686

Aerodynamic design

	unit	values
pressure ratio	[-]	1.65
mass flow	[kg/s]	29.6
tip speed	[m/s]	419
tip solidity	[-]	1.3
aspect ratio	[-]	2.5
number of blades	[-]	47
rotative speed	[rad/s]	1675.51

Material properties

The original material of the rotor 7 is not defined in the NASA report.

Considered properties: 200-grade maraging steel :

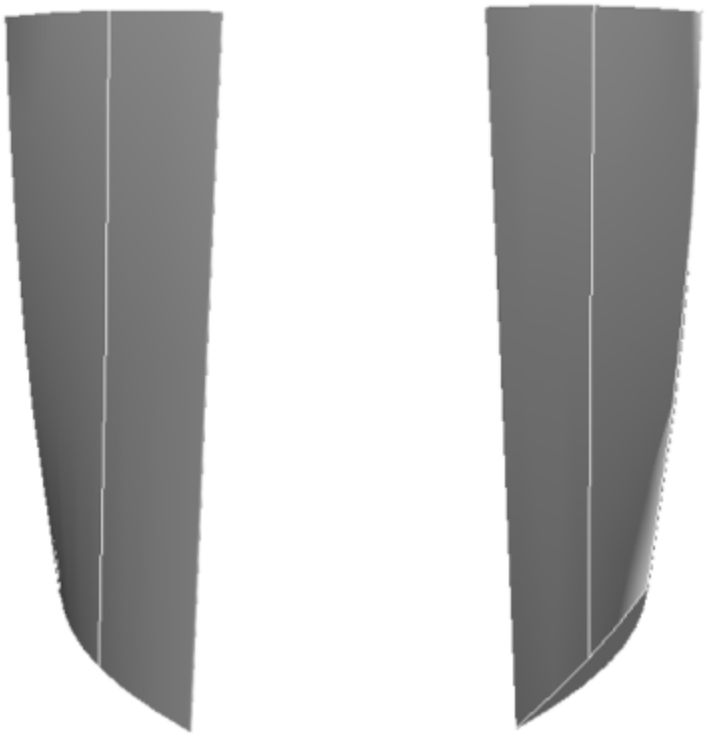
	unité	valeurs
alloy	[-]	18-Ni-200-maraging
Young's modulus	[GPa]	180
density	[kg/m3]	8000

	unité	valeurs
Poisson's ratio	[-]	0.3
yield stress	[GPa]	1.38
	unité	**valeurs**
alloy	[-]	18-Ni-200-maraging
Young's modulus	[GPa]	180
density	[kg/m3]	8000
Poisson's ratio	[-]	0.3
yield stress	[GPa]	1.38

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

1. (1B): 1743.5 rad/s / 277.5 Hz
2. (2B): 6425.5 rad/s / 1022.6 Hz
3. (1T): 8352.5 rad/s / 1329.3 Hz

CAD



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Modèle original

Le rotor 7 fait partie d'un programme de recherche visant à étudier les effets de la forme des pales sur l'efficacité et la marge de décrochage. Une série de rotors transsoniques ont été conçus avec la même distribution de pression totale de sortie pour étudier les effets de la forme des pales. On retrouve par exemple le rotor 6 et 7.

- Rapport technique original [1]:

```
@TechReport{urasek1972design,
  author           = {Urasek, Donald C. and Janetzke, David C.},
  date             = {1972},
  institution      = {NASA Lewis Research Center Cleveland, OH, United
States},
  title            = {Performance of tandem-bladed transonic compressor
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  number           = {NASA-TM X-2484},
  url              = {https://ntrs.nasa.gov/citations/19720011123},
}
```

- Photographie :

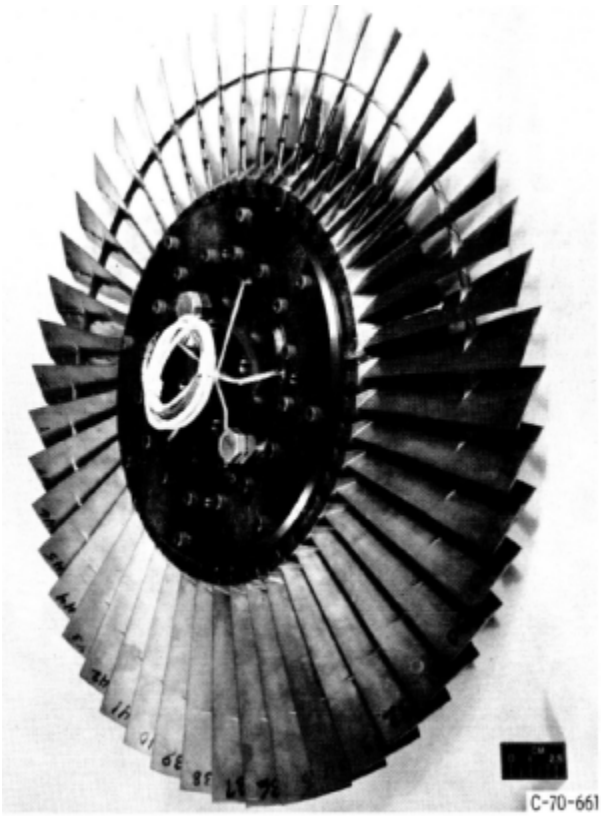

Fig1. https://ntrs.nasa.gov/citations/19720011123 p.58

Documents utiles

- PDF du rapport de la NASA : rotor7.pdf
- Fichier CSV de la géométrie : rotor7_original.csv

Géométrie

La géométrie du rotor 7 est décrite dans le rapport d'origine de la NASA par les tableaux suivants. Les grandeurs sont en pouces et en degrés.

TABLE III. - BLADE GEOMETRY FOR ROTOR 7

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11	0.020	0.148	0.020	0.676	0.324	1.459	30.363
HUB	0.020	0.153	0.020	0.680	0.302	1.477	31.686

Caractéristiques aérodynamiques

	unités	valeurs
taux de compression	[-]	1,65
débit massique	[kg/s]	29,6
vitesse en tête	[m/s]	419
solidité en tête	[-]	1,3

	unités	valeurs
allongement	[-]	2,5
nombre d'aubes	[-]	47
vitesse de rotation	[rad/s]	1675,51

Propriétés matériau

Le matériau original du rotor 7 n'est pas défini dans le rapport de la NASA.

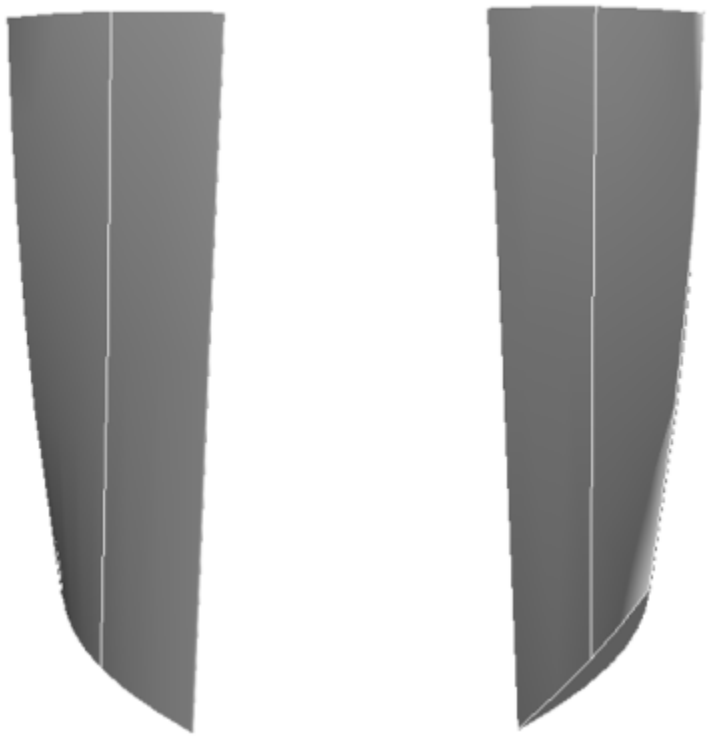
Propriétés considérées : un acier maraging de grade 200 :

	unité	valeurs
alliage	[-]	18-Ni-200-maraging
module d'Young	[GPa]	180
masse volumique	[kg/m3]	8000
coefficient de Poisson	[-]	0,3
limite élastique	[GPa]	1,38

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

1. (1B): 1743,5 rad/s / 277,5 Hz
2. (2B): 6425,5 rad/s / 1022,6 Hz
3. (1T): 8352,5 rad/s / 1329,3 Hz

CAO



1. [a, b] Urasek. «Performance of tandem-bladed transonic compressor rotor with tip speed of 1375 feet per second » 1972. pdf