

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 :

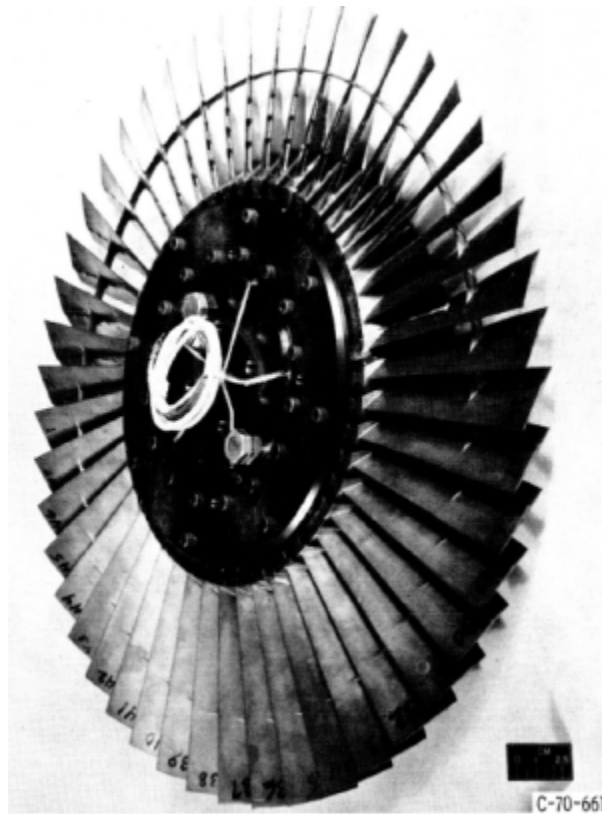


Fig1. <https://ntrs.nasa.gov/citations/19720011123> p.58

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 | | RADII | | BLADE ANGLES | | | DELTA INC |
|-----|---------|-------|-------|-------|--------------|-------|------|--------------|
| | SPAN | RI | RO | KIC | KTC | KOC | | |
| 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 | | | AXIAL DIMENSIONS | | | CONE ANGLE |
|-----|-------------------|-------|-------|------------------|-------|-------|---------------|
| | TI | TM | TO | ZMC | ZTC | ZOC | |
| 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 :

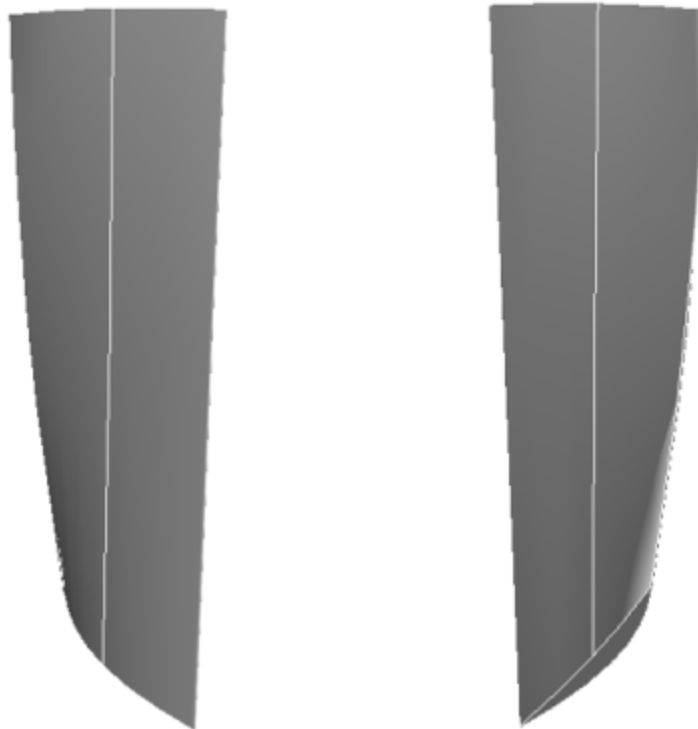
| | unité | valeurs |
|-----------------|----------------------|--------------------|
| alloy | [-] | 18-Ni-200-maraging |
| Young's modulus | [GPa] | 180 |
| density | [kg/m ³] | 8000 |

| | 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/m ³] | 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



Fichiers téléchargeables

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Libre accès

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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.},  
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 }}
```

- Photographie :

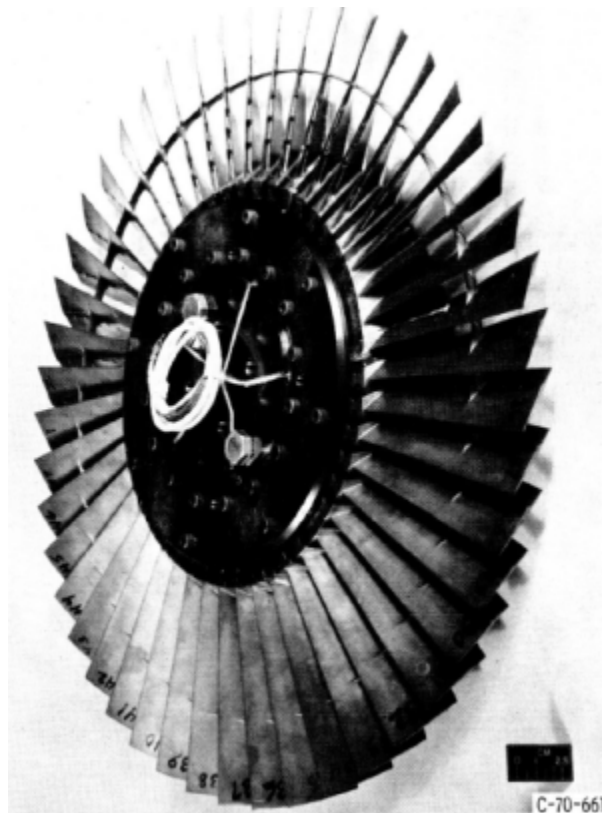


Fig1. <https://ntrs.nasa.gov/citations/19720011123> p.58

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

| RP | PERCENT RADII | | BLADE ANGLES | | | DELTA [INC | |
|-----|---------------|-------|--------------|-------|-------|---------------|------|
| | SPAN | RI | RO | KIC | KTC | | KOC |
| 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 | | | AXIAL DIMENSIONS | | | CONE ANGLE |
|-----|-------------------|-------|-------|------------------|-------|-------|---------------|
| | T1 | TM | TO | ZMC | ZTC | ZOC | |
| 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 |

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 |
| 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.

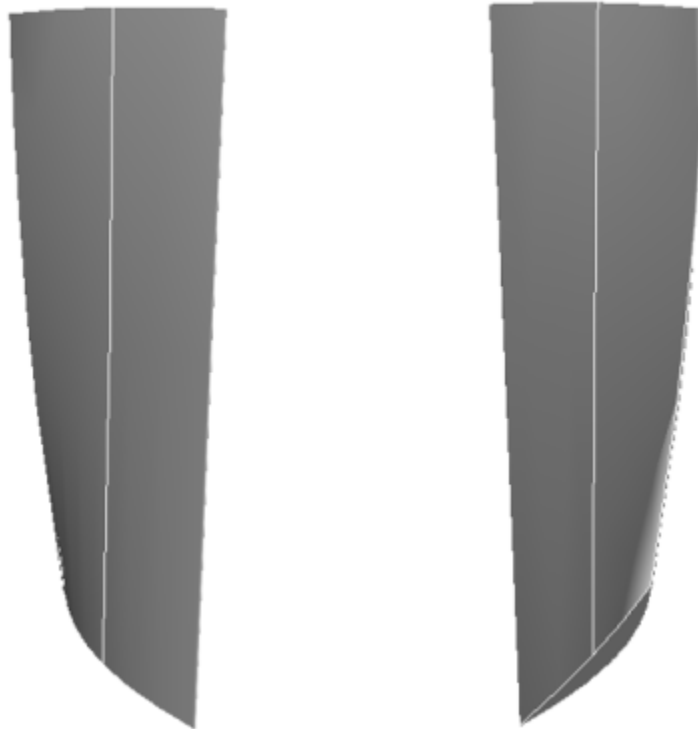
Propriétés considérées : un acier maraging de grade 200 :

| | unité | valeurs |
|-------------------------------|----------------------|--------------------|
| alliage | [-] | 18-Ni-200-maraging |
| module d'Young | [GPa] | 180 |
| masse volumique | [kg/m ³] | 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](#)

Document issu de la page wiki:

https://lava-wiki.meca.polymtl.ca/public/modeles/rotor_07/accueil?rev=1663351991

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