# Rotor 66

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## Original model

Rotor 66 is part of a 51 centimeter-diameter, five-stage compressor having a design weight flow of 29.7 kilograms per second with a pressure ratio of 9.27. Performance data obtained from tests indicated that the first stage was not meeting its design performance.

- Original technical report [(cite:urasek1976design>Urasek. «Performance of inlet stage of transonic compressor» 1976 pdf)]:

```
@TechReport{urasek1976design,
author      = {Urasek, Donald C. and Steinke, Ronald J. and Lewis, George
W.},
title       = {Performance of inlet stage of transonic compressor},
institution = {NASA Lewis Research Center Cleveland, OH, United States},
note        = {NASA-TM X-3345, url~:
\url{https://ntrs.nasa.gov/citations/19760009935}, 1976}}
```

- Picture :




Fig1. https://catalog.archives.gov/id/17423368

```
@Misc{brown1974records,
author   = {Brown, M.},
title    = {First stage rotor wheel from 5 stage compressor. {R}ecords of the
{N}ational {A}eronautics and {S}pace {A}dministration, 1903 - 2006.
{P}hotographs relating to agency activities, facilities and personnel, 1973 -
2013},
note     =
{\href{https://catalog.archives.gov/id/17423368}{https://catalog.archives.gov/
id/17423368}, 1974 }, % for Fig. 1}
```

# Useful documents

- PDF of the NASA report : rotor66.pdf
- CSV file of the blade geometry : rotor66_original.csv

# Geometry

The geometry of rotor 66 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 66

| RP | PERCENT SPAN | RADII RI | RO | BLADE ANGLES KIC | KTC | KOC | DELTA INC | CONE ANGLE |
|---|---|---|---|---|---|---|---|---|
| TIP | 0. | 25.324 | 25.222 | 62.51 | 63.11 | 58.81 | 2.68 | -3.238 |
| 1 | 5. | 24.794 | 24.657 | 61.59 | 62.04 | 57.92 | 2.93 | -4.225 |
| 2 | 10. | 24.216 | 24.092 | 60.60 | 60.87 | 57.03 | 3.20 | -3.688 |
| 3 | 20. | 23.041 | 22.962 | 58.61 | 58.47 | 55.18 | 3.75 | -2.213 |
| 4 | 30. | 21.841 | 21.831 | 56.67 | 55.94 | 52.98 | 4.27 | -0.268 |
| 5 | 38. | 20.866 | 20.927 | 55.14 | 53.75 | 50.75 | 4.69 | 1.522 |
| 6 | 46. | 19.878 | 20.023 | 53.63 | 51.48 | 48.06 | 5.07 | 3.444 |
| 7 | 50. | 19.378 | 19.571 | 52.87 | 50.29 | 46.46 | 5.26 | 4.458 |
| 8 | 70. | 16.811 | 17.310 | 48.96 | 44.21 | 35.52 | 6.08 | 10.070 |
| 9 | 80. | 15.470 | 16.180 | 46.91 | 40.93 | 27.52 | 6.39 | 13.261 |
| 10 | 90. | 14.079 | 15.049 | 44.75 | 37.49 | 17.34 | 6.59 | 16.722 |
| 11 | 95. | 13.361 | 14.484 | 43.60 | 35.80 | 11.47 | 6.65 | 18.571 |
| HUB | 100. | 12.700 | 13.919 | 42.52 | 34.26 | 5.34 | 6.68 | 19.462 |

| RP | BLADE THICKNESSES TI | TM | TO | AXIAL DIMENSIONS ZIC | ZMC | ZTC | ZOC |
|---|---|---|---|---|---|---|---|
| TIP | 0.025 | 0.115 | 0.025 | 0.808 | 1.689 | 1.936 | 2.604 |
| 1 | 0.028 | 0.126 | 0.028 | 0.778 | 1.688 | 1.910 | 2.636 |
| 2 | 0.030 | 0.138 | 0.030 | 0.746 | 1.687 | 1.879 | 2.667 |
| 3 | 0.035 | 0.161 | 0.035 | 0.681 | 1.684 | 1.809 | 2.730 |
| 4 | 0.041 | 0.184 | 0.041 | 0.615 | 1.680 | 1.726 | 2.795 |
| 5 | 0.044 | 0.202 | 0.044 | 0.561 | 1.677 | 1.650 | 2.852 |
| 6 | 0.048 | 0.218 | 0.048 | 0.505 | 1.672 | 1.565 | 2.913 |
| 7 | 0.050 | 0.227 | 0.050 | 0.476 | 1.670 | 1.518 | 2.946 |
| 8 | 0.059 | 0.265 | 0.059 | 0.320 | 1.650 | 1.244 | 3.130 |
| 9 | 0.062 | 0.282 | 0.062 | 0.226 | 1.635 | 1.075 | 3.237 |
| 10 | 0.066 | 0.298 | 0.066 | 0.117 | 1.616 | 0.879 | 3.347 |
| 11 | 0.068 | 0.305 | 0.068 | 0.057 | 1.606 | 0.772 | 3.399 |
| HUB | 0.069 | 0.312 | 0.069 | 0.000 | 1.596 | 0.672 | 3.450 |

# Aerodynamic design

| | unit | values |
|---|---|---|
| **pressure ratio** | [-] | 1.61 |
| **mass flow** | [kg/s] | 29.7 |
| **tip speed** | [m/s] | 426 |
| **tip solidity** | [-] | 1.4 |
| **aspect ratio** | [-] | 3.1 |
| **number of blades** | [-] | 57 |
| **rotative speed** | [rad/s] | 1679.94 |

# Material properties

The original material of the rotor 66 is not defined in the NASA report.

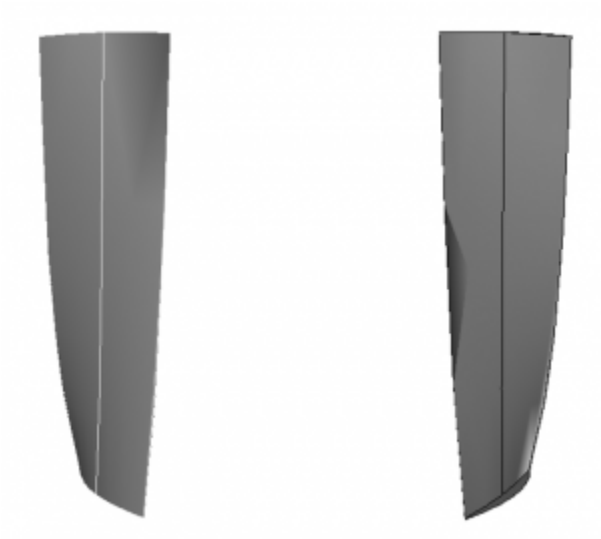
Considered properties: Ti-6Al-4V, generic titanium :

| | 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): 1342.0 rad/s / 213.6 Hz
2. (2B): 4557.2 rad/s / 725.3 Hz
3. (1T): 8209.0 rad/s / 1306.5 Hz

## CAD



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# Modèle original

Le rotor 66 fait partie d'un compresseur à cinq étages de 51 centimètres de diamètre ayant un débit nominal de 29,7 kilogrammes par seconde et un taux de compression de 9,27. Les données de performance obtenues lors de tests ont indiqué que le premier étage n'atteignait pas ses performances de conception.

- Rapport technique original [(cite:urasek1976design>Urasek. «Performance of inlet stage of transonic compressor» 1976 pdf)]:

```
@TechReport{urasek1976design,
author      = {Urasek, Donald C. and Steinke, Ronald J. and Lewis, George
W.},
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\url{https://ntrs.nasa.gov/citations/19760009935}, 1976}}
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- Photographie :




Fig1. https://catalog.archives.gov/id/17423368

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@Misc{brown1974records,
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title    = {First stage rotor wheel from 5 stage compressor. {R}ecords of the
{N}ational {A}eronautics and {S}pace {A}dministration, 1903 - 2006.
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2013},
note     =
{\href{https://catalog.archives.gov/id/17423368}{https://catalog.archives.gov/
id/17423368}, 1974 }, % for Fig. 1}
```

# Documents utiles

- PDF du rapport de la NASA :

rotor66.pdf

- Fichier CSV de la géométrie :

rotor66_original.csv

# Géométrie

La géométrie du rotor 66 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 66

| RP | PERCENT SPAN | RADII RI | RADII RO | BLADE ANGLES KIC | BLADE ANGLES KTC | BLADE ANGLES KOC | DELTA INC | CONE ANGLE |
|---|---|---|---|---|---|---|---|---|
| TIP | 0. | 25.324 | 25.222 | 62.51 | 63.11 | 58.81 | 2.68 | -3.238 |
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| 2 | 10. | 24.216 | 24.092 | 60.60 | 60.87 | 57.03 | 3.20 | -3.688 |
| 3 | 20. | 23.041 | 22.962 | 58.61 | 58.47 | 55.18 | 3.75 | -2.213 |
| 4 | 30. | 21.841 | 21.831 | 56.67 | 55.94 | 52.98 | 4.27 | -0.268 |
| 5 | 38. | 20.866 | 20.927 | 55.14 | 53.75 | 50.75 | 4.69 | 1.522 |
| 6 | 46. | 19.878 | 20.023 | 53.63 | 51.48 | 48.06 | 5.07 | 3.444 |
| 7 | 50. | 19.378 | 19.571 | 52.87 | 50.29 | 46.46 | 5.26 | 4.458 |
| 8 | 70. | 16.811 | 17.310 | 48.96 | 44.21 | 35.52 | 6.08 | 10.070 |
| 9 | 80. | 15.470 | 16.180 | 46.91 | 40.93 | 27.52 | 6.39 | 13.261 |
| 10 | 90. | 14.079 | 15.049 | 44.75 | 37.49 | 17.34 | 6.59 | 16.722 |
| 11 | 95. | 13.361 | 14.484 | 43.60 | 35.80 | 11.47 | 6.65 | 18.571 |
| HUB | 100. | 12.700 | 13.919 | 42.52 | 34.26 | 5.34 | 6.68 | 19.462 |

| RP | BLADE THICKNESSES TI | BLADE THICKNESSES TM | BLADE THICKNESSES TO | AXIAL DIMENSIONS ZIC | AXIAL DIMENSIONS ZMC | AXIAL DIMENSIONS ZTC | AXIAL DIMENSIONS ZOC |
|---|---|---|---|---|---|---|---|
| TIP | 0.025 | 0.115 | 0.025 | 0.808 | 1.689 | 1.936 | 2.604 |
| 1 | 0.028 | 0.126 | 0.028 | 0.778 | 1.688 | 1.910 | 2.636 |
| 2 | 0.030 | 0.138 | 0.030 | 0.746 | 1.687 | 1.879 | 2.667 |
| 3 | 0.035 | 0.161 | 0.035 | 0.681 | 1.684 | 1.809 | 2.730 |
| 4 | 0.041 | 0.184 | 0.041 | 0.615 | 1.680 | 1.726 | 2.795 |
| 5 | 0.044 | 0.202 | 0.044 | 0.561 | 1.677 | 1.650 | 2.852 |
| 6 | 0.048 | 0.218 | 0.048 | 0.505 | 1.672 | 1.565 | 2.913 |
| 7 | 0.050 | 0.227 | 0.050 | 0.476 | 1.670 | 1.518 | 2.946 |
| 8 | 0.059 | 0.265 | 0.059 | 0.320 | 1.650 | 1.244 | 3.130 |
| 9 | 0.062 | 0.282 | 0.062 | 0.226 | 1.635 | 1.075 | 3.237 |
| 10 | 0.066 | 0.298 | 0.066 | 0.117 | 1.616 | 0.879 | 3.347 |
| 11 | 0.068 | 0.305 | 0.068 | 0.057 | 1.606 | 0.772 | 3.399 |
| HUB | 0.069 | 0.312 | 0.069 | 0.000 | 1.596 | 0.672 | 3.450 |

# Caractéristiques aérodynamiques

| | unités | valeurs |
|---|---|---|
| **taux de compression** | [-] | 1,61 |
| **débit massique** | [kg/s] | 29,7 |
| **vitesse en tête** | [m/s] | 426 |
| **solidité en tête** | [-] | 1,4 |
| **allongement** | [-] | 3,1 |
| **nombre d'aubes** | [-] | 57 |
| **vitesse de rotation** | [rad/s] | 1679,94 |

# Propriétés matériau

Le matériau original du rotor 66 n'est pas défini dans le rapport de la NASA.

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

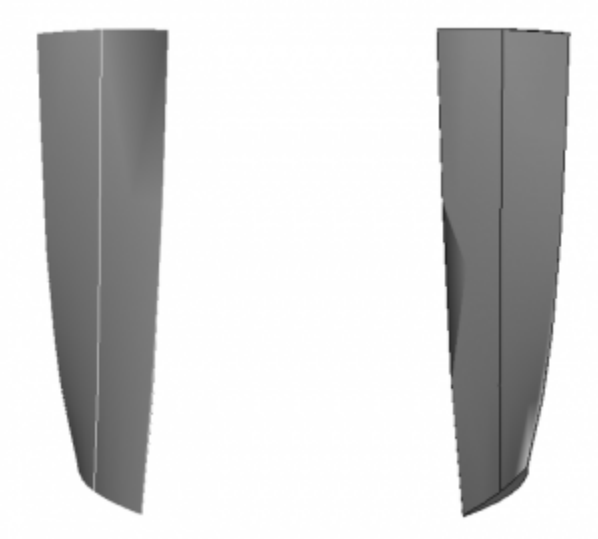
| | unité | valeurs |
|---|---|---|
| **alliage** | [-] | Ti-6Al-4v |
| **module d'Young** | [GPa] | 108 |
| **masse volumique** | [kg/m3] | 4400 |
| **coefficient de Poisson** | [-] | 0,34 |

| | unité | valeurs |
|---|---|---|
| **limite élastique** | [GPa] | 0,824 |

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

1. (1B): 1342,0 rad/s / 213,6 Hz
2. (2B): 4557,2 rad/s / 725,3 Hz
3. (1T): 8209,0 rad/s / 1306,5 Hz

# CAO



Document issu de la page wiki:
**https://wiki.lava.polymtl.ca/public/modeles/rotor_66/accueil?rev=1663351364**

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