

# Rotor 38

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## Original model

Rotor 38 is part of a research program to study a advanced-core compressor design with a high compression ratio (20:1). It is therefore the fourth stage rotor of this eight stage transonic compressor. Of these eight stages, the first four have been designed and tested : rotors 35, 36, 37 and 38. For more information, here is a link to [report from NASA](#).

- Original technical report <sup>[1]</sup>:

```
@TechReport{moore1982design,  
author      = {Moore, R. D. and Reid, Lonnie},  
title       = {Performance of Single-Stage Axial-Flow Transonic Compressor  
With Rotor and Stator Aspect Ratios of 1.63 and 1.77, Respectively, and  
With Design Pressure Ratio of 2.05},  
institution = {NASA Lewis Research Center Cleveland, OH, United States},  
note        = {NASA-TP-2001, url~:  
\url{https://ntrs.nasa.gov/citations/19820014395}, 1982}}
```

- Picture :



Fig1. <https://catalog.archives.gov/id/17466806>

```
@Misc{brown1977records,  
author   = {Brown, M.},  
title    = {Rotor 35 - Rotor 38 - Stator 35 in casing. {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/17466806}{https://catalog.archives.gov/  
id/17466806}, 1977 }, % for Fig. 1}
```

## Useful documents

- PDF of the NASA report :

rotor38.pdf

- CSV file of the blade geometry :

rotor38\_original.csv

## Geometry

The geometry of rotor 38 is described in the [original NASA report](#) by the following tables. The length are in centimeters and the angles in degrees.

(a) Rotor 38

| RP  | PERCENT RADII |        |        | BLADE ANGLES |       |       | DELTA | CONE    |
|-----|---------------|--------|--------|--------------|-------|-------|-------|---------|
|     | SPAN          | RI     | RO     | KIC          | KTC   | KOC   |       |         |
| TIP | 0.            | 25.283 | 24.770 | 62.69        | 65.32 | 55.39 | 2.38  | -15.363 |
| 1   | 5.            | 24.979 | 24.459 | 62.05        | 64.34 | 53.70 | 2.68  | -14.949 |
| 2   | 10.           | 24.641 | 24.148 | 61.34        | 63.25 | 52.12 | 2.98  | -13.674 |
| 3   | 15.           | 24.297 | 23.837 | 60.59        | 62.14 | 50.83 | 3.22  | -12.304 |
| 4   | 30.           | 23.231 | 22.904 | 58.53        | 58.87 | 47.21 | 3.63  | -7.979  |
| 5   | 50.           | 21.762 | 21.660 | 56.51        | 54.97 | 41.52 | 4.35  | -2.243  |
| 6   | 70.           | 20.236 | 20.416 | 54.16        | 51.32 | 34.46 | 5.63  | 3.612   |
| 7   | 85.           | 19.020 | 19.483 | 52.74        | 48.16 | 26.64 | 6.61  | 8.643   |
| 8   | 90.           | 18.593 | 19.172 | 52.55        | 47.49 | 23.76 | 6.88  | 10.561  |
| 9   | 95.           | 18.151 | 18.861 | 52.51        | 47.06 | 20.74 | 7.18  | 12.701  |
| HUB | 100.          | 17.780 | 18.550 | 52.52        | 46.76 | 17.69 | 7.43  | 13.547  |

| RP  | BLADE THICKNESSES |      |      | AXIAL DIMENSIONS |       |       |       |
|-----|-------------------|------|------|------------------|-------|-------|-------|
|     | TI                | TM   | TO   | ZI               | ZMC   | ZTC   | ZO    |
| TIP | .021              | .149 | .021 | .504             | 1.738 | 1.717 | 2.371 |
| 1   | .022              | .157 | .022 | .479             | 1.717 | 1.706 | 2.425 |
| 2   | .022              | .166 | .022 | .450             | 1.695 | 1.687 | 2.477 |
| 3   | .023              | .174 | .023 | .418             | 1.672 | 1.656 | 2.525 |
| 4   | .025              | .202 | .026 | .311             | 1.622 | 1.526 | 2.648 |
| 5   | .029              | .239 | .030 | .200             | 1.586 | 1.409 | 2.797 |
| 6   | .032              | .278 | .033 | .109             | 1.522 | 1.304 | 2.958 |
| 7   | .036              | .311 | .036 | .039             | 1.485 | 1.277 | 3.083 |
| 8   | .037              | .323 | .037 | .021             | 1.468 | 1.226 | 3.122 |
| 9   | .038              | .336 | .038 | .009             | 1.452 | 1.179 | 3.159 |
| HUB | .039              | .346 | .039 | .000             | 1.438 | 1.138 | 3.194 |

## Aerodynamic design

|                  | unit    | values |
|------------------|---------|--------|
| pressure ratio   | [-]     | 2.05   |
| mass flow        | [kg/s]  | 20.2   |
| tip speed        | [m/s]   | 455    |
| tip solidity     | [-]     | 1.3    |
| aspect ratio     | [-]     | 1.63   |
| number of blades | [-]     | 48     |
| rotative speed   | [rad/s] | 1800   |

## Material properties

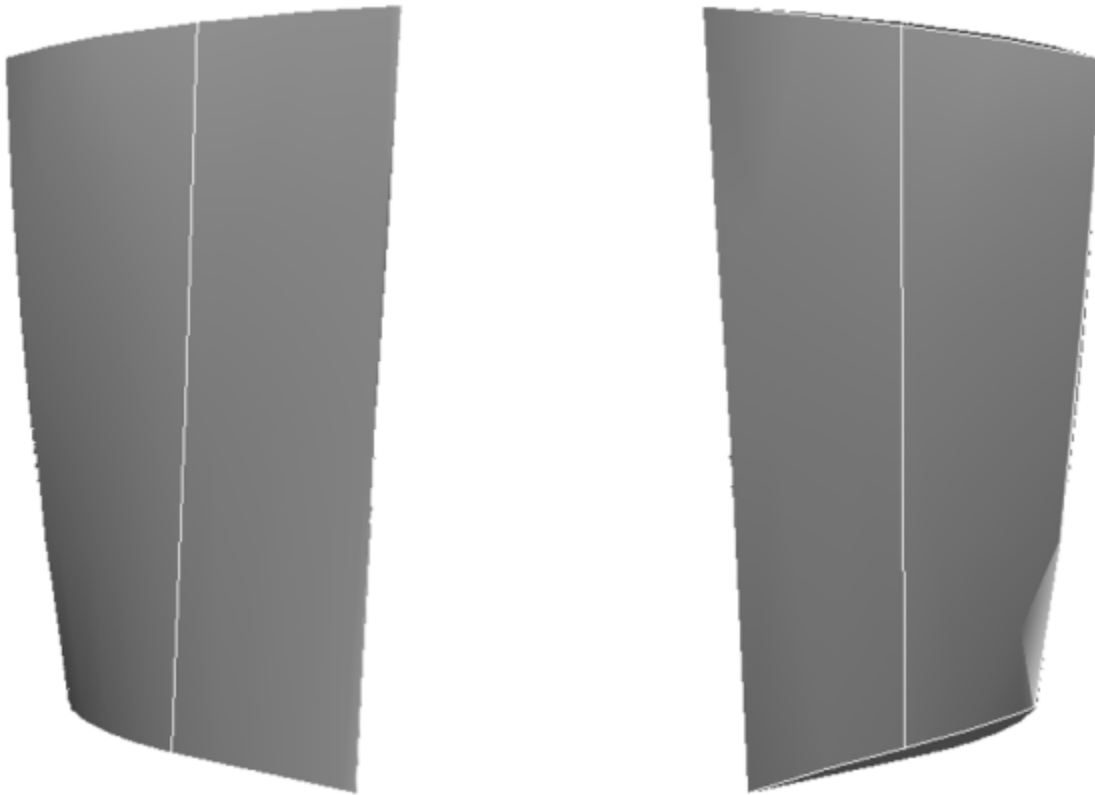
Rotor 38 is made of a 200-grade maraging steel

|                 | unité                | valeurs            |
|-----------------|----------------------|--------------------|
| alloy           | [-]                  | 18-Ni-200-maraging |
| Young's modulus | [GPa]                | 180                |
| density         | [kg/m <sup>3</sup> ] | 8000               |
| Poisson's ratio | [-]                  | 0.3                |
| yield stress    | [GPa]                | 1.38               |

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

1. (1B): 3773.4 rad/s / 600.5 Hz
2. (1T): 13583.8 rad/s / 2161.9 Hz
3. (2B): 14937.7 rad/s / 2377.4 Hz

## CAD



Fichiers téléchargeables

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## Modèle original

Le rotor 38 appartient à un programme de recherche visant à étudier une conception de compresseur possédant un grand taux de compression (20:1). Il est donc le rotor du quatrième étage de ce compresseur transsonique de huit étages. Parmi ces huit étages, les quatre premiers ont été conçus et testés, ils correspondent aux rotors 35, 36, 37 et 38. Pour plus d'information, voici un lien vers [rapport de la NASA](#).

- [Rapport technique original<sup>\[1\]</sup>](#):

```
@TechReport{moore1982design,  
author      = {Moore, R. D. and Reid, Lonnie},  
title       = {Performance of Single-Stage Axial-Flow Transonic Compressor  
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\url{https://ntrs.nasa.gov/citations/19820014395}, 1982}}

- Photographie :



Fig1. <https://catalog.archives.gov/id/17466806>

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{P}hotographs relating to agency activities, facilities and personnel, 1973 -  
2013},  
note     =  
{\href{https://catalog.archives.gov/id/17466806}{https://catalog.archives.gov/  
id/17466806}, 1977 }, % for Fig. 1}
```

## Documents utiles

- PDF du rapport de la NASA :
- Fichier CSV de la géométrie :

rotor38.pdf

rotor38\_original.csv

# Géométrie

La géométrie du rotor 38 est décrite dans le [rapport d'origine de la NASA](#) par les tableaux suivants. Les grandeurs sont en centimètres et en degrés.

(a) Rotor 38

| RP  | PERCENT |        | RADII  |       | BLADE ANGLES |       |      | DELTA   | CONE |
|-----|---------|--------|--------|-------|--------------|-------|------|---------|------|
|     | SPAN    | RI     | RO     | KIC   | KTC          | KOC   | INC  | ANGLE   |      |
| TIP | 0.      | 25.283 | 24.770 | 62.69 | 65.32        | 55.39 | 2.38 | -15.363 |      |
| 1   | 5.      | 24.979 | 24.459 | 62.05 | 64.34        | 53.70 | 2.68 | -14.949 |      |
| 2   | 10.     | 24.641 | 24.148 | 61.34 | 63.25        | 52.12 | 2.98 | -13.674 |      |
| 3   | 15.     | 24.297 | 23.837 | 60.59 | 62.14        | 50.83 | 3.22 | -12.304 |      |
| 4   | 30.     | 23.231 | 22.904 | 58.53 | 58.87        | 47.21 | 3.63 | -7.979  |      |
| 5   | 50.     | 21.762 | 21.660 | 56.51 | 54.97        | 41.52 | 4.35 | -2.243  |      |
| 6   | 70.     | 20.236 | 20.416 | 54.16 | 51.32        | 34.46 | 5.63 | 3.612   |      |
| 7   | 85.     | 19.020 | 19.483 | 52.74 | 48.16        | 26.64 | 6.61 | 8.643   |      |
| 8   | 90.     | 18.593 | 19.172 | 52.55 | 47.49        | 23.76 | 6.88 | 10.561  |      |
| 9   | 95.     | 18.151 | 18.861 | 52.51 | 47.06        | 20.74 | 7.18 | 12.701  |      |
| HUB | 100.    | 17.780 | 18.550 | 52.52 | 46.76        | 17.69 | 7.43 | 13.547  |      |

| RP  | BLADE THICKNESSES |      |      | AXIAL DIMENSIONS |       |       |       |
|-----|-------------------|------|------|------------------|-------|-------|-------|
|     | TI                | TM   | TO   | ZI               | ZMC   | ZTC   | ZO    |
| TIP | .021              | .149 | .021 | .504             | 1.738 | 1.717 | 2.371 |
| 1   | .022              | .157 | .022 | .479             | 1.717 | 1.706 | 2.425 |
| 2   | .022              | .166 | .022 | .450             | 1.695 | 1.687 | 2.477 |
| 3   | .023              | .174 | .023 | .418             | 1.672 | 1.656 | 2.525 |
| 4   | .025              | .202 | .026 | .311             | 1.622 | 1.526 | 2.648 |
| 5   | .029              | .239 | .030 | .200             | 1.586 | 1.409 | 2.797 |
| 6   | .032              | .278 | .033 | .109             | 1.522 | 1.304 | 2.958 |
| 7   | .036              | .311 | .036 | .039             | 1.485 | 1.277 | 3.083 |
| 8   | .037              | .323 | .037 | .021             | 1.468 | 1.226 | 3.122 |
| 9   | .038              | .336 | .038 | .009             | 1.452 | 1.179 | 3.159 |
| HUB | .039              | .346 | .039 | .000             | 1.438 | 1.138 | 3.194 |

## Caractéristiques aérodynamiques

|                            | unités  | valeurs |
|----------------------------|---------|---------|
| <b>taux de compression</b> | [-]     | 2,05    |
| <b>débit massique</b>      | [kg/s]  | 20,2    |
| <b>vitesse en tête</b>     | [m/s]   | 455     |
| <b>solidité en tête</b>    | [-]     | 1,3     |
| <b>allongement</b>         | [-]     | 1,63    |
| <b>nombre d'aubes</b>      | [-]     | 48      |
| <b>vitesse de rotation</b> | [rad/s] | 1800    |

## Propriétés matériau

Le matériau du rotor 38 est un alliage à base de nickel : un acier maraging de grade 200

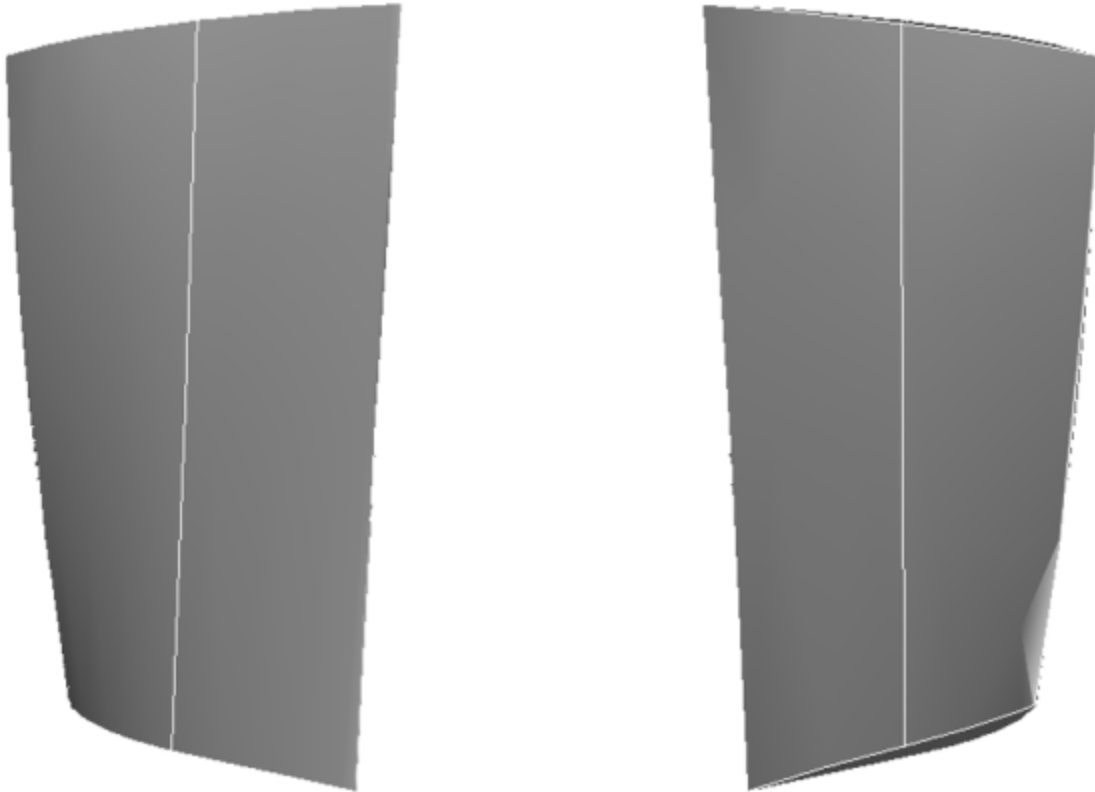
|                               | unité   | valeurs            |
|-------------------------------|---------|--------------------|
| <b>alliage</b>                | [-]     | 18-Ni-200-maraging |
| <b>module d'Young</b>         | [GPa]   | 180                |
| <b>masse volumique</b>        | [kg/m3]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

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

1. (1B): 3773,4 rad/s / 600,5 Hz

2. (1T): 13583,8 rad/s / 2161,9 Hz
3. (2B): 14937,7 rad/s / 2377,4 Hz

## CAO



1. <sup>a, b</sup> Moore. «Performance of Single-Stage Axial-Flow Transonic Compressor With Rotor and Stator Aspect Ratios of 1.63 and 1.77, Respectively, and With Design Pressure Ratio of 2.05 » 1982. [pdf](#)

Document issu de la page wiki:

[https://lava-wiki.meca.polymtl.ca/public/modeles/rotor\\_38/accueil?rev=1663351616](https://lava-wiki.meca.polymtl.ca/public/modeles/rotor_38/accueil?rev=1663351616)

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