

# Rotor 57

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## Original model

Rotor 57 is part of a research program to study fan stages suitable for use in engines for quiet powered lift aircraft. Experimental studies have been conducted on fan stages suitable for use in engines for quiet powered lift aircraft using the externally blown flap. The externally blown flap aircraft requires a large flow of low velocity air for effective lift and low noise during take-off and landing. To meet the low noise requirement, the fans will be required to have low tip speed and low-pressure ratio. The pressure ratios of interest in the program range from 1.15 to 1.4. Rotor 57 has a pressure ratio of 1.38.

- Original technical report [(cite:moore1979design>Moore. «Aerodynamic Performance of 1.38-Pressure-Ratio, Variable-Pitch Fan Stage» 1979. [pdf](#))]:

```
@TechReport{moore1979design,
author      = {Moore, Royce D. and Osborn, Walter M.},
title       = {Aerodynamic Performance of 1.38-Pressure-Ratio, Variable-
Pitch Fan Stage},
institution = {NASA Lewis Research Center Cleveland, OH, United States},
note        = {NASA-TP-1502, url~:
\url{https://ntrs.nasa.gov/citations/19790023042}, 1979}}
```

- Picture :

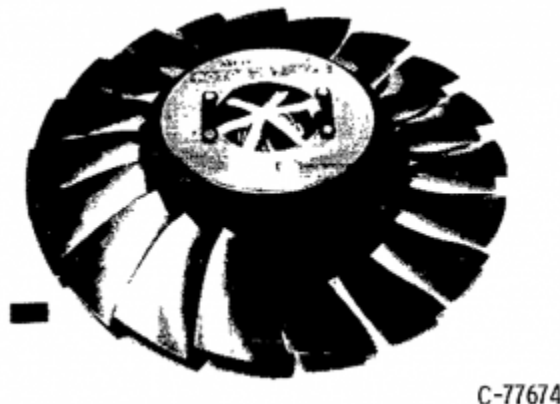


Fig1. <https://ntrs.nasa.gov/citations/19790023042> p.56

## Useful documents

- PDF of the NASA report :

rotor57.pdf

- CSV file of the blade geometry :

rotor57\_original.csv

## Geometry

The geometry of rotor 57 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 57

| RP  | PERCENT<br>SPAN | RADII  |        | BLADE ANGLES |       |        | DELTA<br>INC | CONE<br>ANGLE |
|-----|-----------------|--------|--------|--------------|-------|--------|--------------|---------------|
|     |                 | RI     | RO     | KIC          | KTC   | KOC    |              |               |
| TIP | 0.              | 25.400 | 25.400 | 54.70        | 48.96 | 43.29  | 2.32         | .057          |
| 1   | 5.              | 24.840 | 24.853 | 53.95        | 47.77 | 41.59  | 2.83         | .121          |
| 2   | 10.             | 24.253 | 24.305 | 53.16        | 46.52 | 39.88  | 3.29         | .494          |
| 3   | 15.             | 23.657 | 23.758 | 52.32        | 45.23 | 38.14  | 3.65         | .926          |
| 4   | 30.             | 21.826 | 22.116 | 49.35        | 40.34 | 31.33  | 4.33         | 2.412         |
| 5   | 50.             | 19.338 | 19.926 | 44.86        | 33.47 | 22.10  | 5.14         | 4.385         |
| 6   | 70.             | 16.831 | 17.737 | 40.11        | 24.97 | 9.84   | 7.18         | 6.189         |
| 7   | 85.             | 14.950 | 16.095 | 35.94        | 18.02 | .13    | 10.29        | 7.494         |
| 8   | 90.             | 14.349 | 15.577 | 32.74        | 14.72 | -3.27  | 11.72        | 7.879         |
| 9   | 95.             | 13.763 | 15.000 | 28.62        | 10.89 | -6.82  | 13.31        | 8.247         |
| HUB | 100.            | 13.208 | 14.453 | 24.19        | 6.93  | -10.45 | 14.93        | 8.473         |

| RP  | BLADE THICKNESSES |       |      | AXIAL DIMENSIONS |       |       |       |
|-----|-------------------|-------|------|------------------|-------|-------|-------|
|     | TI                | TH    | TO   | ZI               | ZMC   | ZTC   | ZO    |
| TIP | .015              | .190  | .017 | 1.646            | 4.248 | 4.248 | 7.162 |
| 1   | .018              | .211  | .020 | 1.541            | 4.247 | 4.247 | 7.295 |
| 2   | .021              | .235  | .023 | 1.431            | 4.250 | 4.250 | 7.437 |
| 3   | .022              | .264  | .027 | 1.321            | 4.260 | 4.260 | 7.590 |
| 4   | .030              | .351  | .037 | .969             | 4.181 | 4.181 | 7.852 |
| 5   | .040              | .482  | .050 | .543             | 4.129 | 4.129 | 8.218 |
| 6   | .054              | .655  | .064 | .182             | 4.102 | 4.102 | 8.536 |
| 7   | .069              | .842  | .085 | .067             | 4.195 | 4.195 | 8.772 |
| 8   | .082              | .981  | .098 | .042             | 4.185 | 4.185 | 8.705 |
| 9   | .100              | 1.159 | .114 | .020             | 4.149 | 4.149 | 8.553 |
| HUB | .119              | 1.350 | .132 | -.000            | 4.103 | 4.103 | 8.355 |

## Aerodynamic design

|                  | unit    | values  |
|------------------|---------|---------|
| pressure ratio   | [-]     | 1.38    |
| mass flow        | [kg/s]  | 29.6    |
| tip speed        | [m/s]   | 289.6   |
| aspect ratio     | [-]     | 1.26    |
| number of blades | [-]     | 19      |
| rotative speed   | [rad/s] | 1139.98 |

## Material properties

The original material of the rotor 57 is not defined in the NASA report.

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

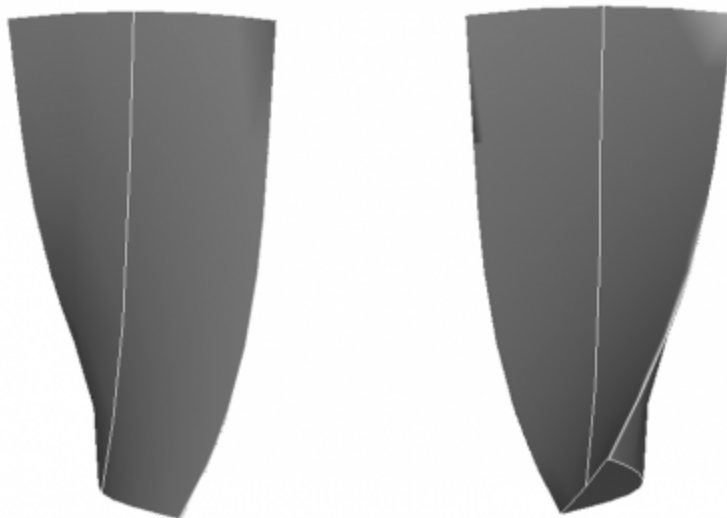
|  | unité | valeurs |
|--|-------|---------|
|--|-------|---------|

|                        | unité   | valeurs   |
|------------------------|---------|-----------|
| <b>alloy</b>           | [-]     | Ti-6Al-4V |
| <b>Young's modulus</b> | [GPa]   | 108       |
| <b>density</b>         | [kg/m3] | 4400      |
| <b>Poisson's ratio</b> | [-]     | 0.34      |
| <b>yield stress</b>    | [GPa]   | 0.824     |

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

1. (1B): 4256.6 rad/s / 677.5 Hz
2. (2B): 11745.8 rad/s / 1869.4 Hz
3. (1T): 14867.1 rad/s / 2366.2 Hz

## CAD



Fichiers téléchargeables

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## Modèle original

Le rotor 57 fait partie d'un programme de recherche visant à étudier les étages de soufflante susceptibles d'être utilisés dans des moteurs d'avions plus silencieux. Des études expérimentales ont été menées sur des étages de soufflante utilisant un volet à soufflage externe. L'utilisation de tel volets nécessite un grand débit d'air à faible vitesse pour une portance efficace et un faible niveau de bruit au décollage et à l'atterrissage. Pour répondre à cette exigence de faible bruit, les soufflantes devront avoir une faible vitesse en tête et un faible taux de compression. Les taux de compression d'intérêt dans le programme varient de 1,15 à 1,4. Le rotor 57 possède un taux de compression de 1,38.

- Rapport technique original [(cite:moore1979design>Moore. «Aerodynamic Performance of 1.38-Pressure-Ratio, Variable-Pitch Fan Stage» 1979. [pdf](#)):

```
@TechReport{moore1979design,  
author      = {Moore, Royce D. and Osborn, Walter M.},  
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Pitch Fan Stage},  
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note        = {NASA-TP-1502, url~:  
\url{https://ntrs.nasa.gov/citations/19790023042}, 1979}}
```

- Photographie :

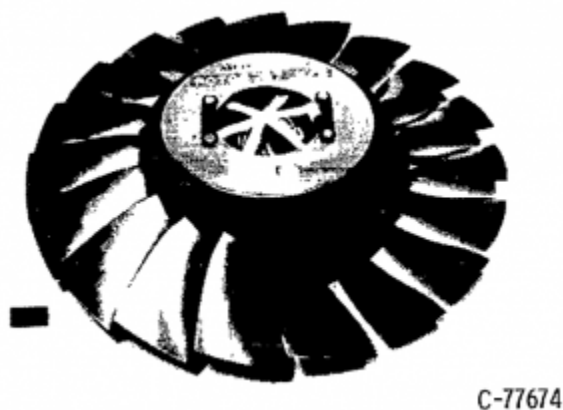


Fig1. <https://ntrs.nasa.gov/citations/19790023042> p.56

## Documents utiles

- PDF du rapport de la NASA :

rotor57.pdf

- Fichier CSV de la géométrie :

rotor57\_original.csv

## Géométrie

La géométrie du rotor 57 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 57

| RP  | PERCENT RADII |        |        | BLADE ANGLES |       |        | DELTA | CONE  |
|-----|---------------|--------|--------|--------------|-------|--------|-------|-------|
|     | SPAN          | RI     | RO     | KIC          | KTC   | KOC    |       |       |
| TIP | 0.            | 25.400 | 25.400 | 54.70        | 48.96 | 43.29  | 2.32  | .057  |
| 1   | 5.            | 24.840 | 24.853 | 53.95        | 47.77 | 41.59  | 2.83  | .121  |
| 2   | 10.           | 24.253 | 24.305 | 53.16        | 46.52 | 39.88  | 3.29  | .494  |
| 3   | 15.           | 23.657 | 23.758 | 52.32        | 45.23 | 38.14  | 3.65  | .926  |
| 4   | 30.           | 21.826 | 22.116 | 49.35        | 40.34 | 31.33  | 4.33  | 2.412 |
| 5   | 50.           | 19.338 | 19.926 | 44.86        | 33.47 | 22.10  | 5.14  | 4.385 |
| 6   | 70.           | 16.831 | 17.737 | 40.11        | 24.97 | 9.84   | 7.18  | 6.189 |
| 7   | 85.           | 14.950 | 16.095 | 35.94        | 18.02 | .13    | 10.29 | 7.494 |
| 8   | 90.           | 14.349 | 15.577 | 32.74        | 14.72 | -3.27  | 11.72 | 7.879 |
| 9   | 95.           | 13.763 | 15.000 | 28.62        | 10.89 | -6.82  | 13.31 | 8.247 |
| HUB | 100.          | 13.208 | 14.453 | 24.19        | 6.93  | -10.45 | 14.93 | 8.473 |

| RP  | BLADE THICKNESSES |       |      | AXIAL DIMENSIONS |       |       |       |
|-----|-------------------|-------|------|------------------|-------|-------|-------|
|     | TI                | TM    | TO   | ZI               | ZMC   | ZTC   | ZO    |
| TIP | .015              | .190  | .017 | 1.646            | 4.248 | 4.248 | 7.162 |
| 1   | .018              | .211  | .020 | 1.541            | 4.247 | 4.247 | 7.295 |
| 2   | .021              | .235  | .023 | 1.431            | 4.250 | 4.250 | 7.437 |
| 3   | .022              | .264  | .027 | 1.321            | 4.260 | 4.260 | 7.590 |
| 4   | .030              | .351  | .037 | .969             | 4.181 | 4.181 | 7.852 |
| 5   | .040              | .482  | .050 | .543             | 4.129 | 4.129 | 8.218 |
| 6   | .054              | .655  | .064 | .182             | 4.102 | 4.102 | 8.536 |
| 7   | .069              | .842  | .085 | .067             | 4.195 | 4.195 | 8.772 |
| 8   | .082              | .981  | .098 | .042             | 4.185 | 4.185 | 8.705 |
| 9   | .100              | 1.159 | .114 | .020             | 4.149 | 4.149 | 8.553 |
| HUB | .119              | 1.350 | .132 | -.000            | 4.103 | 4.103 | 8.355 |

## Caractéristiques aérodynamiques

|                     | unités  | valeurs |
|---------------------|---------|---------|
| taux de compression | [-]     | 1,38    |
| débit massique      | [kg/s]  | 29,6    |
| vitesse en tête     | [m/s]   | 289,6   |
| allongement         | [-]     | 1,26    |
| nombre d'aubes      | [-]     | 19      |
| vitesse de rotation | [rad/s] | 1139,98 |

## Propriétés matériau

Le matériau original du rotor 57 n'est pas défini dans le rapport de la NASA.

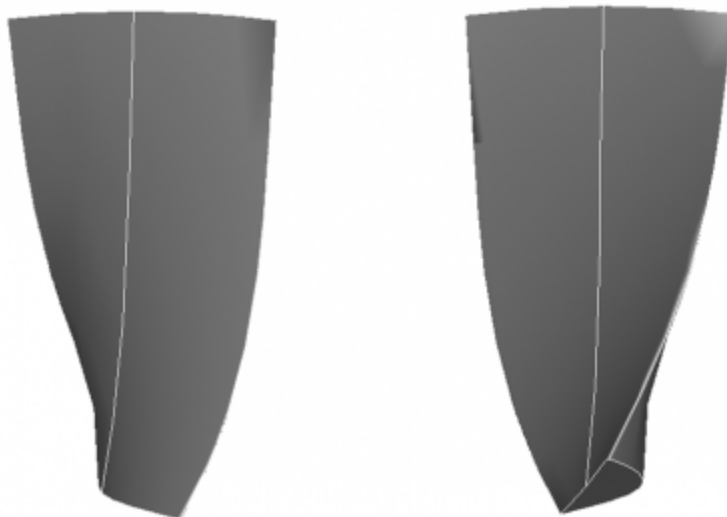
Propriétés considérées : alliage de titane Ti-6Al-4v :

|                        | 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): 4256,6 rad/s / 677,5 Hz
2. (2B): 11745,8 rad/s / 1869,4 Hz
3. (1T): 14867,1 rad/s / 2366,2 Hz

## CAO



Document issu de la page wiki:

[https://wiki.lava.polymtl.ca/public/modeles/rotor\\_57/accueil?rev=1663351481](https://wiki.lava.polymtl.ca/public/modeles/rotor_57/accueil?rev=1663351481)

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