
第9章

結 論

9.1 本研究のまとめ

タービン翼列は、発電用ガスタービンや航空推進用ジェットエンジンの主要な構成要素である。近年開発が盛んに進められている産業用および航空用の小型ガスタービンでは、翼の小型化とタービン入口温度の上昇によって、タービン翼列のレイノルズ数が従来のガスタービンと比較して1桁以上減少するため、低レイノルズ数化により生じる「空気力学特性の悪化」をいかに少なくするかが重要な課題となる。高性能な小型ガスタービンを開発するためには、タービン翼列内部の3次元流動を詳細に把握し、低レイノルズ数域で発生が予測される翼負圧面側の剥離や二次渦の増大などの現象を十分に理解する必要がある。同時に、低レイノルズ数流れ用の数値解析コードを発達させるためにも、数値計算結果の検証に利用できる信頼性の高い実験データが求められている。しかし、低レイノルズ数域の実験データは、直線翼列の2次元流れのデータのみで、環状翼列の3次元流れのデータは皆無である。小型ガスタービンでは、翼弦長に対して翼高さの割合が低い「低アスペクト比翼列」となる傾向が強いことから、高アスペクト比翼列となる大型ガスタービンと比較して、壁面近くでの二次渦の影響が大きいと考えられるので、3次元翼列の実験データが不可欠である。

本研究は、5孔ピトー管、熱線流速計、レーザードップラ流速計などの計測方法を駆使することによって、低レイノルズ数域での環状タービン翼列の空気力学特性を詳細に解明することを目的として実施した。

主な結果を、下記にまとめる。

9.1.1 境界層計算による遷移点・層流剥離点・再付着点の位置と レイノルズ数との関係の予測

第3章では、実験に用いるタービン翼列に対して、単独翼および圧縮機翼列用に提案されている境界層の乱流遷移や層流剥離の経験式を適用して、負圧面上の2次元境界層計算を行い、遷移・剥離・再付着の挙動について検討した。この境界層計算から、レイノルズ数の低下によって、翼の後半部分で剥離領域が大きく発達することを確認した。

9.1.2 タービン静翼の損失と三次元流れへのレイノルズ数と主流乱れ度の影響

第4章では、低レイノルズ数域で作動する環状タービン静翼の三次元流れを測定し、全圧損失および流れの構造に及ぼすレイノルズ数と主流乱れ度の影響を解明した。レイノルズ数が低下すると、翼負圧面側の剥離が発生することによる形状損失の増加と、壁面近くの二次渦が強くなることによる二次損失の増加が起こり、全圧損失が急激に増加した。一般に「損失はレイノルズ数の-0.2乗に比例する」と言われているが、境界層が層流剥離を起こすような低レイノルズ数域においては、レイノルズ数の影響がさらに大きいことを明らかにした。本実験に用いたタービン静翼（フリーボルテックス法による設計）では、高レイノルズ数域では-0.2乗則に従うが、低レイノルズ数域では次のようになった（図4.22～図4.27参照）。

(1) 総全圧損失	: -0.35 乗	($Re_{out,NZ} = 18.6 \times 10^4$ 以下)
(2) 形状損失	: -0.30 乗	($Re_{out,NZ} = 18.6 \times 10^4$ 以下)
(3) ミッドスパン損失	: -0.50 乗	($Re_{out,NZ} = 9.0 \times 10^4$ 以下)
(4) 二次損失	: -0.47 乗	($Re_{out,NZ} = 27.1 \times 10^4$ 以下)
チップ側二次損失	: -0.20 乗のまま	
ハブ側二次損失	: -0.85 乗	($Re_{out,NZ} = 27.1 \times 10^4$ 以下)

このことは、小型ガスタービンやマイクロガスタービンを設計する際に、従来

の-0.2乗則を用いてタービン翼列の性能予測を行うと、実機において必要な性能を得られない可能性が大きいことを意味する。一方、主流乱れ度の影響は、レイノルズ数に比べて少なく、低レイノルズ数域では、レイノルズ数が流れを支配する重要なパラメータであることを明らかにした。

9.1.3 チップクリアランスの影響と低レイノルズ数化の関係

第5章では、チップクリアランス流れと低レイノルズ数化の関係を調べた。環状タービン翼列で、チップクリアランス（翼先端隙間）がある場合とない場合の2種類の条件で、レイノルズ数を変えた実験を行い、チップクリアランス流れの存在が流れ場に与える影響が、レイノルズ数の低下によってどのように変化するかを検討した。レイノルズ数が低下するとチップクリアランス流れが全圧損失分布と3次元流れの構造に変化をもたらすが、測定面全体のチップクリアランス損失は、レイノルズ数が変わってもほぼ一定であった。このことは、形状損失と二次流れ損失がレイノルズ数の低下とともに急増すること（第4章）と対照的であった。

9.1.4 タービン動翼ミッドスパンでの非定常流れの解明

第6章では、低レイノルズ数域におけるタービン動翼ミッドスパンでの流れを、レーザードップラ流速計（LDV）を用いて計測し、上流側のタービン静翼の流れが下流のタービン動翼の流れに与える空気力学的な影響（静動翼干渉）を調べた。詳細な測定データを、絶対座標系と相対座標系の両方から解析し、時間平均流れと非定常流れ、およびそれらの差から変動流れ成分を求めるなどして、様々な解析を試みた。タービン静翼のウェーク（後流）が、動翼上流で動翼周りの速度分布によって弓状にねじ曲げられながら動翼内部に流入し、動翼下流で動翼負圧面側の剥離領域や動翼ウェークと干渉して、複雑な非定常流れを発生させることを示した。乱れ成分を調べたところ、主流領域では、流れ方向とその垂直方向の乱れ成分がほぼ同じ乱れ強さ（等方性乱れ）であるのに対して、ウェーク部分では、流れ方向とその垂直方向の乱れ成分が2倍近い差があり、非等方性の強い乱れであることが分かった。

9.1.5 タービン動翼ミッドスパンでの非定常流れに対するレイノルズ数と主流乱れ度の影響

第7章では、第6章で説明したタービン動翼ミッドスパンの非定常流れに対して、レイノルズ数と主流乱れ度がどのような影響を及ぼすかを調べた。レイノルズ数が低下するほど、静翼や動翼のウェークが急増するとともに、動翼負圧面側での剥離が上流側から発生して剥離領域が増えた。また、レイノルズ数が低下するほど流れの非定常性が強くなることも明らかにした。動翼出口直後のウェークのエネルギー消散厚さ（損失と対応）とレイノルズ数の関係は、高レイノルズ数域ではレイノルズ数の-0.2乗則に従うが、低レイノルズ数域では次のように変化した。

エネルギー消散厚さ : -0.50乗 ($Re_{out,RT} = 5.4 \times 10^4$ 以下)

一方、主流乱れ度の影響はレイノルズ数の影響ほど顕著ではなく、翼後縁直後のウェーク形状は主流乱れ度が変わっても変化が見られなかったが、下流に流れる際にウェークが誘起する非定常変動は、主流乱れ度が高いほど少なくなった。この理由は、主流乱れ度が高いほど、主流とウェークの混合が促進されるからである。

9.1.6 タービン動翼まわり全体の非定常流れ

第8章では、低レイノルズ数域におけるタービン動翼全体の非定常流れを計測する。静翼のウェークと二次渦が動翼内部の流れに与える影響を捉え、それらと動翼内部の剥離領域、動翼後縁のウェーク、流路渦やチップクリアランスからの漏れ渦との非定常干渉を解明した。

9.2 低レイノルズ数域におけるタービン翼設計への指針

本研究で得られた結論に基づいて、低レイノルズ数域で作動するタービン翼列の設計への指針を考察する。

10^4 オーダの低レイノルズ数域では、剥離の発生や二次渦の増加によって、損失の低下が顕著である。レイノルズ数が低下するほど境界層厚さが増加することは、

流体力学的に避けることのできない物理現象であるので、低レイノルズ数域で作動するタービン翼列の性能低下を防ぐことは難しい。一般に言われている「損失はレイノルズ数の-0.2乗(-1/5乗則)に比例する」という相関は、平板上の乱流境界層厚さの発達がレイノルズ数の-0.2乗に比例するという事実由来している。従来の高レイノルズ数域で作動するタービン翼列では、翼面境界層を全て乱流と見なすことができるので、タービン翼列の設計時に、この-0.2乗則で損失を予測することは妥当である。しかし、境界層が層流域、剥離域、乱流遷移域を含む低レイノルズ数流れに対して、この-0.2乗則を適用することは危険である。その根拠として、平板上の層流境界層の厚さはレイノルズ数の-0.5乗に比例することと、剥離の有無で損失が大きく異なることが挙げられる。小型ガスタービンやマイクロガスタービンのタービン翼列を設計する際には、レイノルズ数の影響に-0.2乗を用いて性能予測を行うと、実機で得られる性能が設計値を大きく下回ってしまい、所望の性能が得られない可能性が高い。これを防ぐためには、翼列設計の際に、レイノルズ数による性能低下を-0.2乗則よりも大きめに見積もる必要がある。本実験で用いたタービン静翼と動翼（フリーボルトックス法による設計）では、出口流れ基準のレイノルズ数 Re_{out} が 10^4 オーダにまで低下すると、全圧損失およびエネルギー消散厚さがレイノルズ数の-0.35乗～-0.50乗に従って変化した。したがって、低レイノルズ数域で作動するタービン翼列を設計する際には、少なくとも-0.35乗則（あるいは-1/3乗則）を用いて性能予測をする必要があると考えられる。

本研究の測定結果から、低レイノルズ数域では、主流乱れ度が増加しても翼負圧面側の後半部で層流剥離が発生してしまうことが分かる。通常のタービン翼列は、境界層の発達を抑えるために、前縁から後縁までキャンバーラインが滑らかに変化する（速度分布も滑らかになる）形状に設計するが、低レイノルズ数域では、翼前半部でのキャンバーラインの曲げを大きくする（速度変化も前縁側で大きい）ほうが、翼前半部で剥離した流れを翼後半部で再付着させられて、性能が改善される可能性がある。

また、非定常流れの計測結果から、低レイノルズ数域では流れの非定常変動が大幅に増加することが明らかになった。低レイノルズ数域では静翼の主流とウェークの速度差が Negative Jet として作用して、動翼まわりの流れに大きく影響を及

ぼすためである。高レイノルズ数域では、動翼前縁の形状を鋭く設計する（前縁半径を小さくする）ほど形状損失が少なくなる（Benner ら, 1997）ことが報告されているが、低レイノルズ数域においては、動翼入口での流れ角変動が大きいため、前縁形状を鋭くするとかえって性能が悪くなることが予想される。すなわち、静翼ウエークは動翼前縁に対して負圧面側にぶつかる（負のインシデンスになる）ため、前縁形状が鋭い場合には、翼前縁の正圧面側に非定常な剥離を引き起こすことが考えられる。

レイノルズ数の低下に伴う性能劣化を少しでも防ぐためには、タービン翼列形状を最適化する必要があるが、従来のような高レイノルズ数域における経験則に基づいた翼列設計に頼っているだけでは、低レイノルズ数域において高性能なタービン翼列は望めそうもない。低レイノルズ数域におけるタービン翼列形状の最適化には、近年発達が著しい数値流体力学（CFD）を適用することが不可欠と考えられるが、現状のタービン翼列の CFD 解析では、高レイノルズ数域での流れの解析例は多数報告されているものの、層流域、剥離域、乱流遷移域を含む低レイノルズ数流れに対する解析例はまだ少なく、その予測精度には改善の余地が残されている。低レイノルズ数域におけるタービン翼列の CFD 解析を発達させるには、検証に使える信頼性の高い実験データが求められるが、低レイノルズ数域での非定常流れの計測は皆無であった。本研究で得られた豊富な実験データが、低レイノルズ数用 CFD コードの信頼性の向上に利用されることにより、低レイノルズ数域用に最適化されたタービン翼列の開発につながることを期待できる。

9.3 今後の課題

本論文の実験研究について、今後に残された研究課題を以下に列記する。

本研究で用いたレーザードップラ流速計（LDV）は、2次元 LDV であるため、周方向と軸方向の速度成分は計測できるが、半径方向の速度成分を測定できていない。タービン動翼内部の流れを完全に把握するためには、流れの3次元速度成分を全て測定する必要がある。この目的のために、レーザープローブの設置角度を任意に変更し、違う方向から流れ場を測定することによって、3次元速度分布

を測定できるように、トラバース装置の改造を進めている。

また、LDVの詳細な速度場と同時に、非定常な圧力場も捉えることによって、タービン動翼の流れの理解を深めることができる。壁面の静圧分布や動翼下流での非定常全圧分布の測定を行うために、高応答の圧力センサを用いた測定を実施できるように、風洞と計測システムの改良を続けている。

低レイノルズ数域において、翼形状の違いによって剥離位置がどのように変化するかを実証するため、キャンパーラインの形状を変化させた新型動翼を製作することを計画している。

これらの課題を実施することによって、低レイノルズ数域でのタービン翼列の流れをより良く理解し、最適設計の指針をさらに明確にできると考えられる。

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「低レイノルズ数域における環状タービン翼列特性 (第 4 報: 主流乱れの影響)」, 松沼孝幸, 阿部裕幸, 村田耕史 (筑波大学大学院), 筒井康賢, 第 26 回ガスタービン定期講演会講演論文集 (名古屋), pp.109-114, 平成 10 年 5 月 29 日 (金), 名古屋国際会議場

「低レイノルズ数域における環状タービン翼列特性 (第 5 報: 動翼まわりの流れ)」, 松沼孝幸, 阿部裕幸, 筒井康賢, 第 13 回ガスタービン秋季講演会講演論文集 (函館), pp.43-48, 平成 10 年 10 月 8 日 (木), 大沼セミナーハウス

「低レイノルズ数域における環状タービン翼列特性 (第 6 報: 損失予測法の検討)」, 松沼孝幸, 阿部裕幸, 筒井康賢, 第 27 回ガスタービン定期講演会講演論文集 (東京), pp.39-44, 平成 11 年 5 月 26 日 (水), 早稲田大学国際会議場

「低レイノルズ数域における環状タービン翼列特性 (第 7 報: LDV 計測)」, 松沼孝幸, 阿部裕幸, 筒井康賢, 第 14 回ガスタービン秋季講演会講演論文集 (郡山), pp.1-6, 平成 11 年 8 月 26 日 (木), 郡山ビッグパレットふくしま

「低レイノルズ数域において作動するタービン動翼内の非定常流れ」
松沼孝幸, 阿部裕幸, 筒井康賢, 第 15 回ガスタービン秋季講演会講演論文集 (北九州), pp.181-186, 平成 12 年 11 月 9 日 (木), 北九州国際会議場

「静翼ウェークと二次渦により生じるタービン動翼内の非定常流れ」
松沼孝幸, 阿部裕幸, 筒井康賢, 第 16 回ガスタービン秋季講演会講演論文集 (秋田市), pp.75-80, 平成 13 年 10 月 25 日 (木), 秋田市文化会館

付録 1

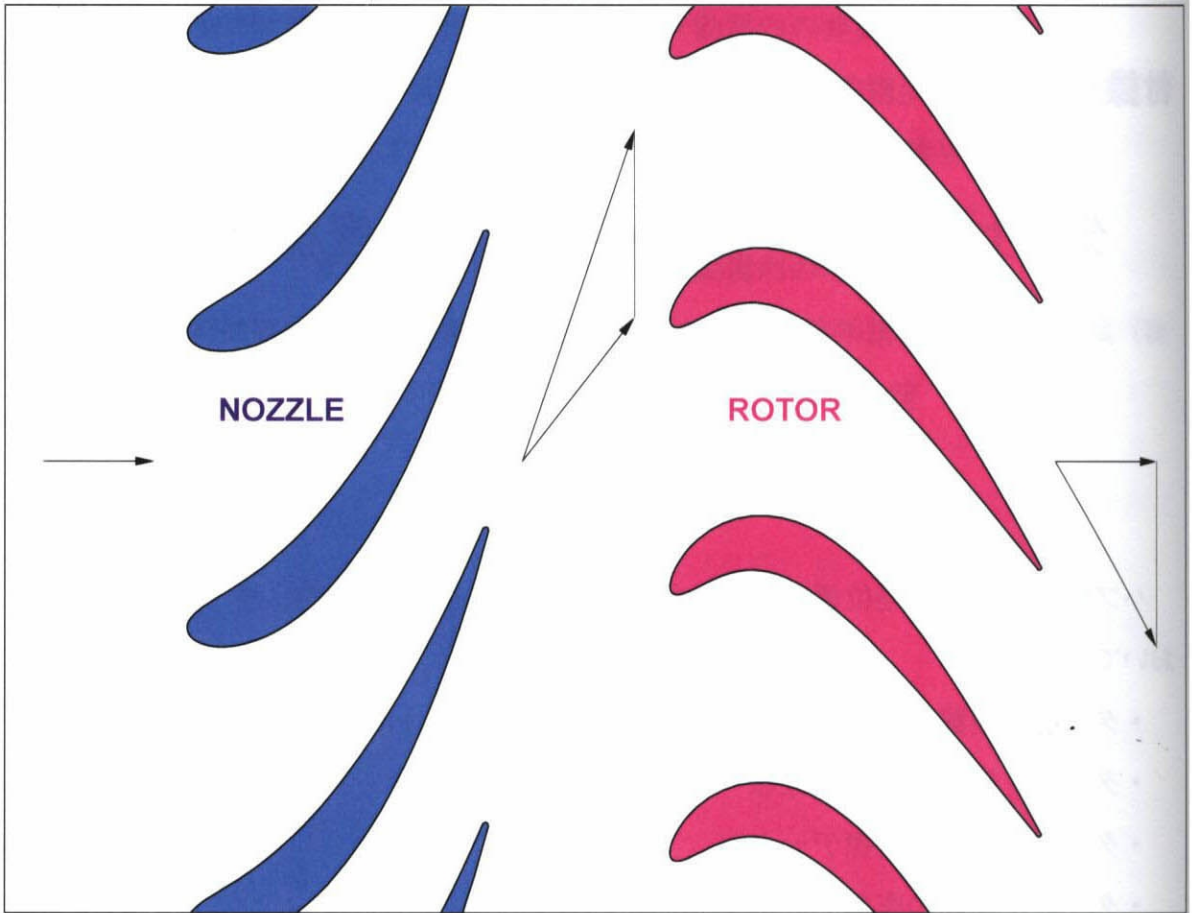
タービン静翼・動翼の翼配置と座標データ

ハブ側壁面，各半径位置（測定を行った 21 の半径方向位置），チップ側壁面において，

- ・タービン静翼・動翼の配置（原寸）と設計点における速度三角形
- ・タービン静翼・動翼の仕様
- ・タービン静翼の座標データ
- ・タービン動翼の座標データ

を付図 1.1 から付図 1.25 および付表 1.1 から付表 1.73 に示す。

なお，翼列の座標データは，3次元座標（デカルト座標）と2次元座標（軸方向と周方向の座標）の両方を掲載する。



付図 1.1 タービン静翼・動翼の配置（原寸）と設計点における速度三角形（ハブ側壁面，半径 $R=175\text{mm}$ ，スパン方向位置 $y/H=0.000$ ）

付表 1.1 タービン静翼・動翼の仕様（ハブ側壁面，半径 $R=175\text{mm}$ ）

		Nozzle	Rotor
Chord	C	66.08 mm	58.65 mm
Axial Chord	C_{ax}	40.22 mm	49.43 mm
Blade Pitch	S	39.27 mm	35.47 mm
Solidity	C/S	1.683	1.654
Inlet Blade Angle	α_1	0.00 deg	51.86 deg
Exit Blade Angle	α_2	71.10 deg	58.74 deg
Blade Turning Angle	$\alpha_2 - \alpha_1$	71.10 deg	110.60 deg
Stagger Angle	ξ	52.78 deg	33.43 deg
Trailing Edge Diameter	d_{TE}	0.6 mm	0.6 mm
Flow Coefficient	Φ	0.607	
Blade Loading Coefficient	ψ	1.773	
Reaction	Λ	0.113	
Nozzle / Rotor Axial Spacing	L_{NR}	24.19 mm	

付表 1.2 タービン静翼の座標 (ハブ側壁面, 半径 $R=175\text{mm}$)
 ハブ側壁面からの距離 $y=0.0\text{mm}$, スパン方向位置 $y/H=0.000$

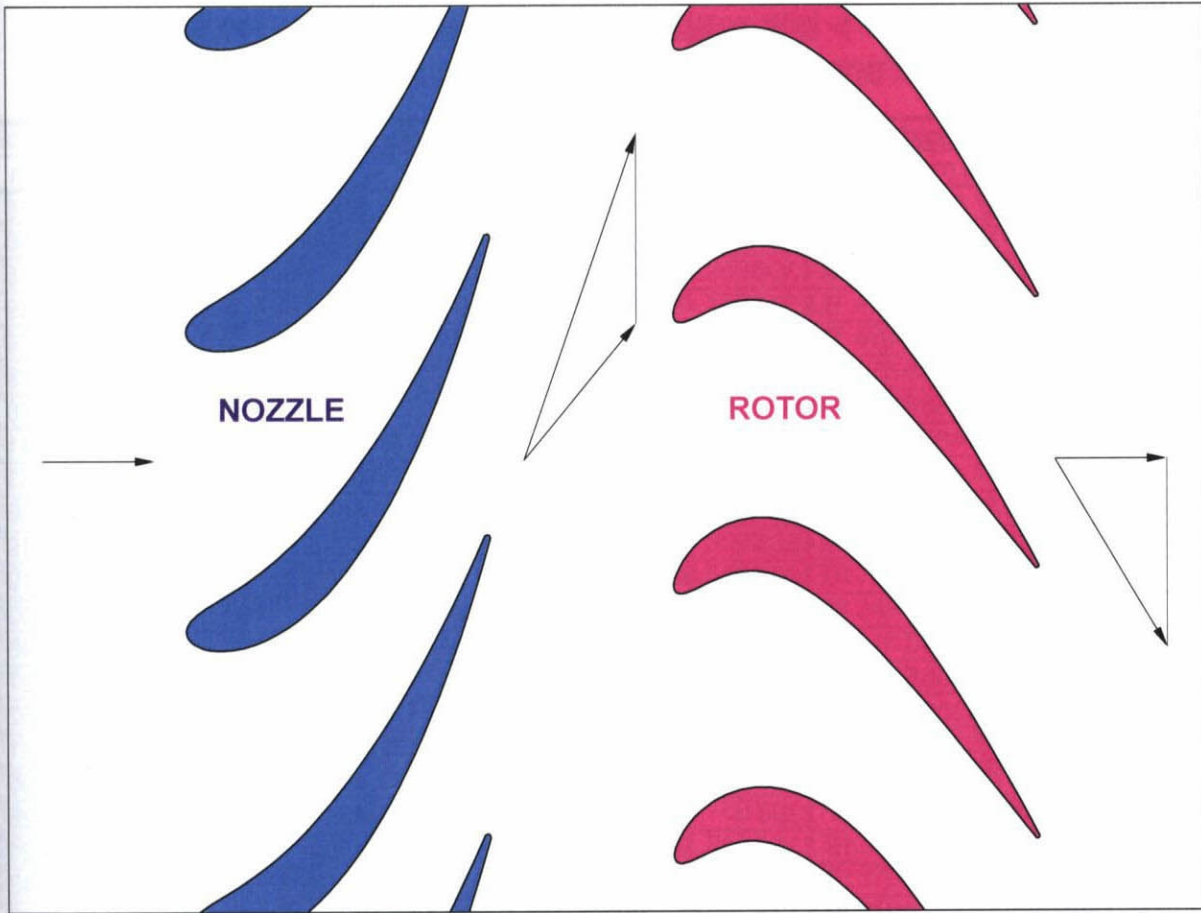
No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	0.0000	175.0000	6.4000	0.0000	0.0000	175.0000	6.4000	0.0000
2	-0.4909	174.9993	6.4695	-0.4909	0.4906	174.9993	6.4738	0.4906
3	-0.8401	174.9980	6.6041	-0.8401	0.8373	174.9980	6.6259	0.8373
4	-1.1751	174.9960	6.7997	-1.1751	1.1640	174.9961	6.8603	1.1640
5	-1.5025	174.9935	7.0524	-1.5025	1.4717	174.9938	7.1809	1.4717
6	-1.8255	174.9905	7.3587	-1.8255	1.7563	174.9912	7.5912	1.7563
7	-2.1471	174.9868	7.7158	-2.1472	2.0113	174.9884	8.0941	2.0113
8	-2.4702	174.9826	8.1214	-2.4703	2.2285	174.9858	8.6919	2.2286
9	-2.7981	174.9776	8.5738	-2.7982	2.3981	174.9836	9.3862	2.3982
10	-3.1347	174.9719	9.0728	-3.1349	2.5091	174.9820	10.1774	2.5092
11	-3.5035	174.9649	9.6492	-3.5037	2.5487	174.9814	11.1143	2.5488
12	-4.0583	174.9529	10.5508	-4.0587	2.4413	174.9830	12.6023	2.4414
13	-4.6067	174.9394	11.4549	-4.6072	2.1521	174.9868	14.0884	2.1522
14	-5.1702	174.9236	12.3723	-5.1710	1.7013	174.9917	15.5616	1.7013
15	-5.7648	174.9050	13.3110	-5.7658	1.1036	174.9965	17.0139	1.1036
16	-6.4035	174.8828	14.2764	-6.4049	0.3707	174.9996	18.4399	0.3707
17	-7.0972	174.8560	15.2717	-7.0991	-0.4878	174.9993	19.8365	-0.4878
18	-7.8550	174.8236	16.2984	-7.8576	-1.4642	174.9939	21.2018	-1.4642
19	-8.6845	174.7844	17.3569	-8.6881	-2.5521	174.9814	22.5357	-2.5522
20	-9.5922	174.7369	18.4467	-9.5970	-3.7464	174.9599	23.8387	-3.7467
21	-10.5835	174.6797	19.5664	-10.5900	-5.0431	174.9273	25.1118	-5.0438
22	-11.6627	174.6109	20.7145	-11.6714	-6.4393	174.8815	26.3568	-6.4408
23	-12.8336	174.5288	21.8891	-12.8451	-7.9328	174.8201	27.5754	-7.9355
24	-14.0992	174.4311	23.0884	-14.1145	-9.5219	174.7408	28.7695	-9.5266
25	-15.4618	174.3156	24.3104	-15.4820	-11.2058	174.6409	29.9408	-11.2135
26	-16.9236	174.1798	25.5533	-16.9501	-12.9837	174.5177	31.0914	-12.9956
27	-18.4863	174.0208	26.8154	-18.5209	-14.8557	174.3683	32.2227	-14.8736
28	-20.1514	173.8359	28.0952	-20.1962	-16.8217	174.1896	33.3364	-16.8477
29	-21.9201	173.6217	29.3913	-21.9778	-18.8822	173.9783	34.4338	-18.9190
30	-23.7936	173.3749	30.7024	-23.8675	-21.0377	173.7309	35.5161	-21.0887
31	-25.7728	173.0918	32.0275	-25.8669	-23.2890	173.4434	36.5845	-23.3583
32	-27.8589	172.7683	33.3656	-27.9779	-25.6369	173.1120	37.6397	-25.7295
33	-30.0528	172.4002	34.7160	-30.2025	-28.0826	172.7321	38.6826	-28.2045
34	-32.3557	171.9829	36.0782	-32.5429	-30.6271	172.2991	39.7136	-30.7856
35	-34.7687	171.5113	37.4516	-35.0016	-33.2721	171.8079	40.7333	-33.4759
36	-37.2934	170.9801	38.8360	-37.5816	-36.0192	171.2531	41.7418	-36.2785
37	-39.9317	170.3833	40.2312	-40.2866	-38.8705	170.6285	42.7393	-39.1974
38	-42.6865	169.7141	41.6373	-43.1215	-41.8292	169.9274	43.7258	-42.2381
39	-45.5619	168.9648	43.0542	-46.0930	-44.8993	169.1421	44.7010	-45.4071
40	-48.5653	168.1262	44.4823	-49.2113	-48.0880	168.2633	45.6646	-48.7147
41	-51.7152	167.1841	45.9220	-52.4991	-51.4130	167.2773	46.6157	-52.1829
42	-51.7538	167.1722	46.0440	-52.5395	-51.5819	167.2253	46.5683	-52.3596
43	-51.8216	167.1512	46.1371	-52.6105	-51.6901	167.1919	46.5384	-52.4729
44	-51.8502	167.1423	46.2502	-52.6405	-51.7790	167.1644	46.4674	-52.5659
45	-51.8352	167.1470	46.3662	-52.6247	-51.8352	167.1470	46.3662	-52.6247

X_{3D}, Y_{3D}, Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)
 X_{2D}, Z : Two-dimensional coordinate system (axial and circumferential coordinates)

付表 1.3 タービン動翼の座標 (ハブ側壁面, 半径 $R=175\text{mm}$)
 ハブ側壁面からの距離 $y=0.0\text{mm}$, スパン方向位置 $y/H=0.000$

No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	0.0000	175.0000	9.4000	0.0000	0.0000	175.0000	9.4000	0.0000
2	0.1716	174.9999	9.8423	0.1716	-0.3936	174.9996	9.1332	-0.3936
3	0.1586	174.9999	10.2643	0.1586	-0.8185	174.9981	9.0622	-0.8185
4	0.0425	175.0000	10.7546	0.0425	-1.3439	174.9948	9.0984	-1.3439
5	-0.1619	174.9999	11.3132	-0.1619	-1.9662	174.9890	9.2420	-1.9662
6	-0.4395	174.9995	11.9364	-0.4395	-2.6770	174.9795	9.4963	-2.6771
7	-0.7728	174.9983	12.6192	-0.7728	-3.4642	174.9657	9.8666	-3.4644
8	-1.1425	174.9963	13.3554	-1.1425	-4.3126	174.9469	10.3591	-4.3130
9	-1.5280	174.9933	14.1372	-1.5280	-5.2042	174.9226	10.9815	-5.2050
10	-1.9078	174.9896	14.9554	-1.9078	-6.1174	174.8931	11.7431	-6.1186
11	-2.2784	174.9852	15.8448	-2.2785	-7.0740	174.8570	12.7067	-7.0759
12	-2.7071	174.9791	17.1159	-2.7072	-8.3385	174.8012	14.3615	-8.3417
13	-2.9683	174.9748	18.2513	-2.9684	-9.2982	174.7528	16.1522	-9.3026
14	-3.0935	174.9727	19.2871	-3.0937	-9.9439	174.7173	18.0428	-9.9493
15	-3.1081	174.9724	20.2682	-3.1083	-10.2728	174.6982	19.9882	-10.2787
16	-3.0231	174.9739	21.2420	-3.0233	-10.2956	174.6969	21.9412	-10.3015
17	-2.8354	174.9770	22.2480	-2.8355	-10.0370	174.7119	23.8623	-10.0425
18	-2.5333	174.9817	23.3117	-2.5334	-9.5294	174.7404	25.7257	-9.5341
19	-2.1044	174.9874	24.4445	-2.1044	-8.8062	174.7783	27.5202	-8.8099
20	-1.5394	174.9932	25.6472	-1.5394	-7.8968	174.8217	29.2450	-7.8995
21	-0.8345	174.9980	26.9146	-0.8345	-6.8252	174.8669	30.9053	-6.8269
22	0.0095	175.0000	28.2389	0.0095	-5.6101	174.9100	32.5088	-5.6111
23	0.9885	174.9972	29.6120	0.9885	-4.2667	174.9480	34.0634	-4.2671
24	2.0957	174.9875	31.0266	2.0957	-2.8073	174.9775	35.5768	-2.8074
25	3.3229	174.9685	32.4762	3.3231	-1.2425	174.9956	37.0554	-1.2425
26	4.6612	174.9379	33.9552	4.6618	0.4183	174.9995	38.5045	0.4183
27	6.1013	174.8936	35.4593	6.1025	2.1664	174.9866	39.9287	2.1665
28	7.6336	174.8334	36.9847	7.6360	3.9937	174.9544	41.3315	3.9940
29	9.2488	174.7554	38.5285	9.2531	5.8923	174.9008	42.7160	5.8934
30	10.9375	174.6579	40.0883	10.9446	7.8547	174.8236	44.0847	7.8573
31	12.6906	174.5393	41.6621	12.7017	9.8735	174.7213	45.4393	9.8787
32	14.4993	174.3983	43.2483	14.5159	11.9416	174.5921	46.7817	11.9509
33	16.3550	174.2341	44.8456	16.3789	14.0524	174.4349	48.1130	14.0675
34	18.2495	174.0458	46.4529	18.2827	16.1991	174.2486	49.4343	16.2223
35	20.1749	173.8332	48.0694	20.2199	18.3756	174.0326	50.7465	18.4095
36	22.1236	173.5959	49.6944	22.1830	20.5760	173.7862	52.0502	20.6237
37	24.0886	173.3342	51.3276	24.1653	22.7947	173.5091	53.3458	22.8597
38	26.0631	173.0483	52.9684	26.1604	25.0268	173.2012	54.6337	25.1129
39	28.0411	172.7388	54.6168	28.1625	27.2676	172.8626	55.9143	27.3792
40	30.0170	172.4064	56.2726	30.1662	29.5132	172.4934	57.1875	29.6549
41	31.9863	172.0520	57.9360	32.1671	31.7606	172.0938	58.4534	31.9376
42	32.1114	172.0287	58.0174	32.2944	31.8285	172.0812	58.4912	32.0066
43	32.1600	172.0196	58.1235	32.3438	31.9435	172.0599	58.4861	32.1236
44	32.1650	172.0186	58.2404	32.3489	32.0478	172.0405	58.4367	32.2297
45	32.1256	172.0260	58.3504	32.3088	32.1256	172.0260	58.3504	32.3088

X_{3D}, Y_{3D}, Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)
 X_{2D}, Z : Two-dimensional coordinate system (axial and circumferential coordinates)



付図 1.2 タービン静翼・動翼の配置（原寸）と設計点における速度三角形
 （測定位置 $N_R=1$ ，半径 $R=177.5\text{mm}$ ，スパン方向位置 $y/H=0.033$ ）

付表 1.4 タービン静翼・動翼の仕様（測定位置 $N_R=1$ ，半径 $R=177.5\text{mm}$ ）

		Nozzle	Rotor
Chord	C	66.17 mm	58.50 mm
Axial Chord	C_{ax}	40.38 mm	48.86 mm
Blade Pitch	S	39.83 mm	35.98 mm
Solidity	C/S	1.661	1.626
Inlet Blade Angle	α_1	0.00 deg	50.41 deg
Exit Blade Angle	α_2	70.85 deg	59.10 deg
Blade Turning Angle	$\alpha_2 - \alpha_1$	70.85 deg	109.50 deg
Stagger Angle	ξ	52.66 deg	33.17 deg
Trailing Edge Diameter	d_{TE}	0.6 mm	0.6 mm
Flow Coefficient	ϕ	0.599	
Blade Loading Coefficient	ψ	1.723	
Reaction	λ	0.138	
Nozzle / Rotor Axial Spacing	L_{NR}	24.43 mm	

付表 1.5 タービン静翼の座標 (測定位置 $N_R=1$, 半径 $R=177.5\text{mm}$)
 ハブ側壁面からの距離 $y=2.5\text{mm}$, スパン方向位置 $y/H=0.033$

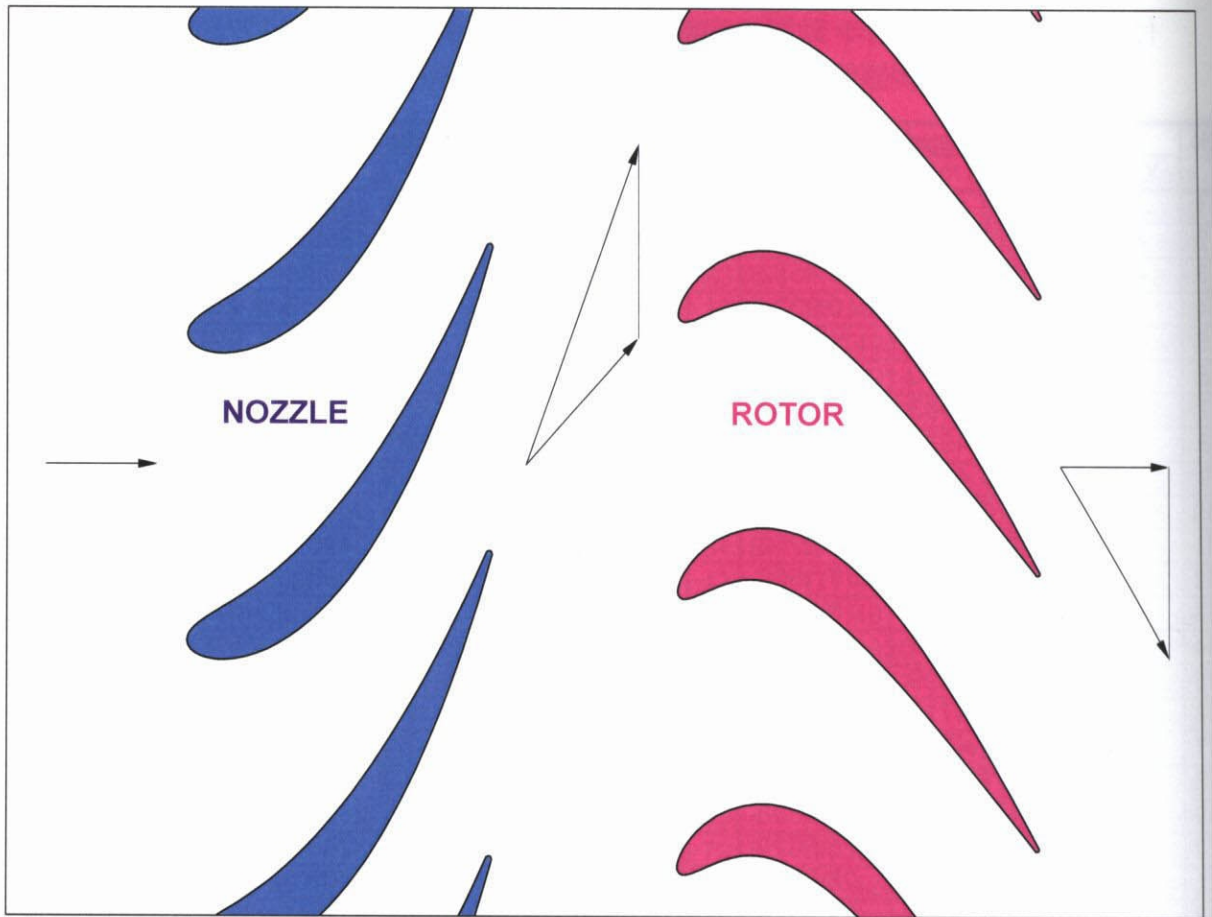
No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-0.0068	177.5000	6.2311	-0.0068	-0.0068	177.5000	6.2311	-0.0068
2	-0.4984	177.4993	6.3008	-0.4984	0.4846	177.4993	6.3052	0.4846
3	-0.8482	177.4980	6.4360	-0.8482	0.8318	177.4981	6.4579	0.8318
4	-1.1837	177.4961	6.6324	-1.1837	1.1589	177.4962	6.6933	1.1589
5	-1.5117	177.4936	6.8861	-1.5117	1.4670	177.4939	7.0154	1.4670
6	-1.8353	177.4905	7.1936	-1.8353	1.7519	177.4914	7.4275	1.7519
7	-2.1576	177.4869	7.5521	-2.1576	2.0070	177.4887	7.9326	2.0070
8	-2.4815	177.4827	7.9593	-2.4816	2.2241	177.4861	8.5330	2.2241
9	-2.8103	177.4778	8.4136	-2.8104	2.3933	177.4839	9.2303	2.3933
10	-3.1481	177.4721	8.9146	-3.1482	2.5035	177.4823	10.0248	2.5036
11	-3.5183	177.4651	9.4935	-3.5185	2.5418	177.4818	10.9657	2.5419
12	-4.0757	177.4532	10.3992	-4.0760	2.4318	177.4833	12.4597	2.4319
13	-4.6271	177.4397	11.3076	-4.6276	2.1393	177.4871	13.9515	2.1393
14	-5.1941	177.4240	12.2295	-5.1948	1.6846	177.4920	15.4302	1.6846
15	-5.7926	177.4055	13.1730	-5.7936	1.0827	177.4967	16.8878	1.0827
16	-6.4357	177.3833	14.1434	-6.4371	0.3452	177.4997	18.3188	0.3452
17	-7.1341	177.3566	15.1439	-7.1360	-0.5181	177.4992	19.7203	-0.5181
18	-7.8969	177.3242	16.1759	-7.8996	-1.4995	177.4937	21.0904	-1.4995
19	-8.7318	177.2851	17.2398	-8.7353	-2.5924	177.4811	22.4290	-2.5925
20	-9.6449	177.2378	18.3350	-9.6497	-3.7918	177.4595	23.7366	-3.7921
21	-10.6418	177.1807	19.4602	-10.6481	-5.0936	177.4269	25.0144	-5.0943
22	-11.7265	177.1122	20.6137	-11.7350	-6.4947	177.3811	26.2640	-6.4962
23	-12.9028	177.0304	21.7938	-12.9142	-7.9931	177.3199	27.4872	-7.9958
24	-14.1736	176.9332	22.9985	-14.1887	-9.5868	177.2409	28.6859	-9.5915
25	-15.5410	176.8183	24.2259	-15.5610	-11.2751	177.1415	29.8619	-11.2827
26	-17.0073	176.6833	25.4742	-17.0334	-13.0570	177.0191	31.0172	-13.0688
27	-18.5740	176.5255	26.7416	-18.6080	-14.9326	176.8708	32.1532	-14.9503
28	-20.2424	176.3420	28.0267	-20.2866	-16.9017	176.6935	33.2716	-16.9273
29	-22.0138	176.1296	29.3281	-22.0706	-18.9646	176.4840	34.3737	-19.0009
30	-23.8891	175.8851	30.6445	-23.9618	-21.1218	176.2388	35.4608	-21.1720
31	-25.8691	175.6048	31.9748	-25.9616	-23.3740	175.9543	36.5340	-23.4421
32	-27.9550	175.2848	33.3182	-28.0718	-25.7218	175.6264	37.5940	-25.8127
33	-30.1474	174.9211	34.6738	-30.2943	-28.1664	175.2510	38.6418	-28.2860
34	-32.4475	174.5091	36.0412	-32.6310	-30.7086	174.8234	39.6776	-30.8638
35	-34.8561	174.0440	37.4197	-35.0841	-33.3498	174.3389	40.7022	-33.5492
36	-37.3747	173.5205	38.8093	-37.6566	-36.0917	173.7919	41.7156	-36.3451
37	-40.0050	172.9331	40.2096	-40.3517	-38.9360	173.1769	42.7180	-39.2552
38	-42.7496	172.2751	41.6209	-43.1740	-41.8857	172.4872	43.7095	-42.2845
39	-45.6122	171.5394	43.0429	-46.1297	-44.9445	171.7156	44.6897	-45.4392
40	-48.5997	170.7171	44.4761	-49.2283	-48.1192	170.8531	45.6583	-48.7289
41	-51.7296	169.7949	45.9208	-52.4913	-51.4264	169.8870	46.6145	-52.1744
42	-51.7687	169.7830	46.0437	-52.5322	-51.5945	169.8360	46.5671	-52.3502
43	-51.8361	169.7624	46.1371	-52.6027	-51.7029	169.8030	46.5377	-52.4635
44	-51.8643	169.7538	46.2503	-52.6322	-51.7922	169.7758	46.4671	-52.5568
45	-51.8488	169.7585	46.3662	-52.6160	-51.8488	169.7585	46.3662	-52.6160

X_{3D}, Y_{3D}, Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)
 X_{2D}, Z : Two-dimensional coordinate system (axial and circumferential coordinates)

付表 1.6 タービン動翼の座標 (測定位置 $N_R=1$, 半径 $R=177.5\text{mm}$)
 ハブ側壁面からの距離 $y=2.5\text{mm}$, スパン方向位置 $y/H=0.033$

No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-0.4631	177.4994	9.6194	-0.4631	-0.4631	177.4994	9.6194	-0.4631
2	-0.2868	177.4998	10.0458	-0.2868	-0.8525	177.4980	9.3666	-0.8525
3	-0.2911	177.4998	10.4552	-0.2911	-1.2686	177.4955	9.3042	-1.2686
4	-0.3946	177.4996	10.9324	-0.3946	-1.7807	177.4911	9.3474	-1.7808
5	-0.5831	177.4990	11.4775	-0.5831	-2.3853	177.4840	9.4965	-2.3854
6	-0.8417	177.4980	12.0868	-0.8417	-3.0742	177.4734	9.7547	-3.0744
7	-1.1537	177.4963	12.7554	-1.1537	-3.8356	177.4586	10.1273	-3.8359
8	-1.5001	177.4937	13.4773	-1.5002	-4.6546	177.4390	10.6202	-4.6551
9	-1.8611	177.4902	14.2450	-1.8612	-5.5135	177.4143	11.2408	-5.5144
10	-2.2157	177.4862	15.0497	-2.2158	-6.3914	177.3849	11.9983	-6.3928
11	-2.5596	177.4815	15.9258	-2.5597	-7.3085	177.3495	12.9545	-7.3105
12	-2.9515	177.4755	17.1809	-2.9516	-8.5153	177.2956	14.5926	-8.5186
13	-3.1810	177.4715	18.3056	-3.1812	-9.4237	177.2497	16.3616	-9.4281
14	-3.2781	177.4697	19.3346	-3.2783	-10.0252	177.2167	18.2264	-10.0305
15	-3.2670	177.4699	20.3115	-3.2672	-10.3173	177.1999	20.1436	-10.3231
16	-3.1581	177.4719	21.2820	-3.1582	-10.3106	177.2003	22.0674	-10.3165
17	-2.9482	177.4755	22.2842	-2.9483	-10.0292	177.2164	23.9598	-10.0345
18	-2.6258	177.4806	23.3428	-2.6259	-9.5044	177.2454	25.7958	-9.5090
19	-2.1789	177.4866	24.4688	-2.1790	-8.7687	177.2833	27.5646	-8.7723
20	-1.5984	177.4928	25.6629	-1.5984	-7.8505	177.3263	29.2655	-7.8531
21	-0.8805	177.4978	26.9200	-0.8805	-6.7731	177.3707	30.9036	-6.7748
22	-0.0260	177.5000	28.2326	-0.0260	-5.5546	177.4131	32.4863	-5.5555
23	0.9612	177.4974	29.5928	0.9612	-4.2097	177.4501	34.0213	-4.2101
24	2.0747	177.4879	30.9936	2.0748	-2.7504	177.4787	35.5161	-2.7505
25	3.3065	177.4692	32.4285	3.3067	-1.1868	177.4960	36.9769	-1.1868
26	4.6480	177.4391	33.8922	4.6486	0.4719	177.4994	38.4089	0.4719
27	6.0904	177.3955	35.3804	6.0916	2.2173	177.4862	39.8164	2.2174
28	7.6242	177.3362	36.8896	7.6265	4.0416	177.4540	41.2030	4.0419
29	9.2406	177.2593	38.4168	9.2448	5.9371	177.4007	42.5716	5.9382
30	10.9305	177.1631	39.9597	10.9374	7.8966	177.3243	43.9246	7.8992
31	12.6851	177.0461	41.5164	12.6959	9.9130	177.2230	45.2638	9.9182
32	14.4959	176.9071	43.0853	14.5120	11.9794	177.0953	46.5909	11.9885
33	16.3546	176.7450	44.6652	16.3778	14.0893	176.9399	47.9071	14.1042
34	18.2533	176.5590	46.2548	18.2856	16.2364	176.7558	49.2134	16.2591
35	20.1843	176.3486	47.8536	20.2281	18.4147	176.5422	50.5107	18.4479
36	22.1404	176.1137	49.4608	22.1983	20.6184	176.2984	51.7995	20.6651
37	24.1148	175.8543	51.0762	24.1897	22.8423	176.0241	53.0803	22.9058
38	26.1010	175.5705	52.6990	26.1960	25.0816	175.7190	54.3534	25.1658
39	28.0931	175.2627	54.3294	28.2117	27.3318	175.3831	55.6193	27.4409
40	30.0858	174.9317	55.9672	30.2318	29.5891	175.0164	56.8778	29.7279
41	32.0749	174.5779	57.6126	32.2521	31.8509	174.6189	58.1290	32.0244
42	32.2000	174.5549	57.6924	32.3793	31.9194	174.6064	58.1674	32.0940
43	32.2491	174.5458	57.7982	32.4292	32.0344	174.5854	58.1617	32.2108
44	32.2547	174.5448	57.9150	32.4349	32.1384	174.5662	58.1118	32.3166
45	32.2158	174.5520	58.0252	32.3953	32.2158	174.5520	58.0252	32.3953

X_{3D}, Y_{3D}, Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)
 X_{2D}, Z : Two-dimensional coordinate system (axial and circumferential coordinates)



付図 1.3 タービン静翼・動翼の配置（原寸）と設計点における速度三角形（測定位置 $N_R=2$ ，半径 $R=181\text{mm}$ ，スパン方向位置 $y/H=0.080$ ）

付表 1.7 タービン静翼・動翼の仕様（測定位置 $N_R=2$ ，半径 $R=181\text{mm}$ ）

		Nozzle	Rotor
Chord	C	66.30 mm	58.32 mm
Axial Chord	C_{ax}	40.62 mm	48.07 mm
Blade Pitch	S	40.62 mm	36.69 mm
Solidity	C/S	1.632	1.590
Inlet Blade Angle	α_1	0.00 deg	48.25 deg
Exit Blade Angle	α_2	70.50 deg	59.59 deg
Blade Turning Angle	$\alpha_2 - \alpha_1$	70.50 deg	107.84 deg
Stagger Angle	ξ	52.49 deg	35.22 deg
Trailing Edge Diameter	d_{TE}	0.6 mm	0.6 mm
Flow Coefficient	ϕ	0.587	
Blade Loading Coefficient	ψ	1.658	
Reaction	Λ	0.171	
Nozzle / Rotor Axial Spacing	L_{NR}	24.77 mm	

付表 1.8 タービン静翼の座標 (測定位置 $N_R=2$, 半径 $R=181\text{mm}$)
 ハブ側壁面からの距離 $y=6.0\text{mm}$, スパン方向位置 $y/H=0.080$

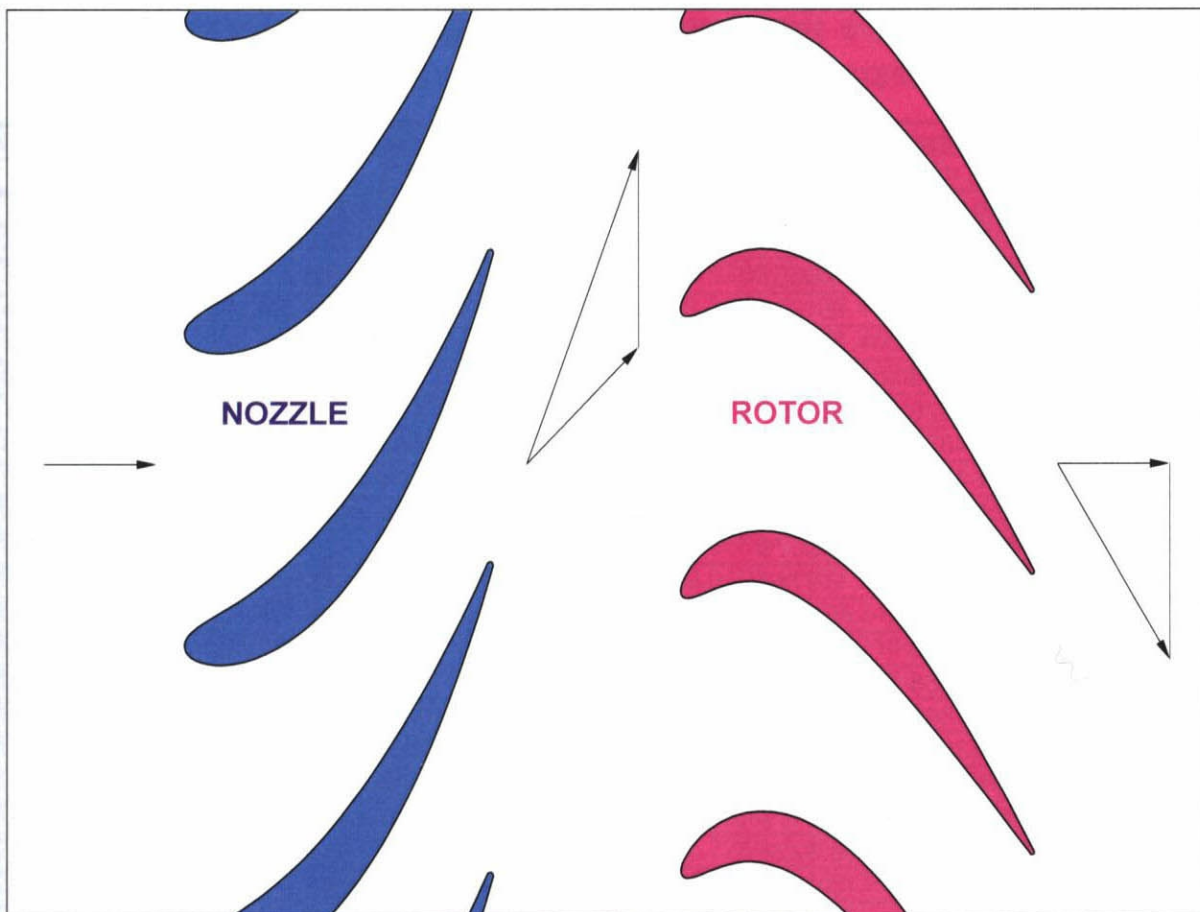
No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	0.0000	175.0000	6.4000	0.0000	0.0000	175.0000	6.4000	0.0000
2	-0.4909	174.9993	6.4695	-0.4909	0.4906	174.9993	6.4738	0.4906
3	-0.8401	174.9980	6.6041	-0.8401	0.8373	174.9980	6.6259	0.8373
4	-1.1751	174.9960	6.7997	-1.1751	1.1640	174.9961	6.8603	1.1640
5	-1.5025	174.9935	7.0524	-1.5025	1.4717	174.9938	7.1809	1.4717
6	-1.8255	174.9905	7.3587	-1.8255	1.7563	174.9912	7.5912	1.7563
7	-2.1471	174.9868	7.7158	-2.1472	2.0113	174.9884	8.0941	2.0113
8	-2.4702	174.9826	8.1214	-2.4703	2.2285	174.9858	8.6919	2.2286
9	-2.7981	174.9776	8.5738	-2.7982	2.3981	174.9836	9.3862	2.3982
10	-3.1347	174.9719	9.0728	-3.1349	2.5091	174.9820	10.1774	2.5092
11	-3.5035	174.9649	9.6492	-3.5037	2.5487	174.9814	11.1143	2.5488
12	-4.0583	174.9529	10.5508	-4.0587	2.4413	174.9830	12.6023	2.4414
13	-4.6067	174.9394	11.4549	-4.6072	2.1521	174.9868	14.0884	2.1522
14	-5.1702	174.9236	12.3723	-5.1710	1.7013	174.9917	15.5616	1.7013
15	-5.7648	174.9050	13.3110	-5.7658	1.1036	174.9965	17.0139	1.1036
16	-6.4035	174.8828	14.2764	-6.4049	0.3707	174.9996	18.4399	0.3707
17	-7.0972	174.8560	15.2717	-7.0991	-0.4878	174.9993	19.8365	-0.4878
18	-7.8550	174.8236	16.2984	-7.8576	-1.4642	174.9939	21.2018	-1.4642
19	-8.6845	174.7844	17.3569	-8.6881	-2.5521	174.9814	22.5357	-2.5522
20	-9.5922	174.7369	18.4467	-9.5970	-3.7464	174.9599	23.8387	-3.7467
21	-10.5835	174.6797	19.5664	-10.5900	-5.0431	174.9273	25.1118	-5.0438
22	-11.6627	174.6109	20.7145	-11.6714	-6.4393	174.8815	26.3568	-6.4408
23	-12.8336	174.5288	21.8891	-12.8451	-7.9328	174.8201	27.5754	-7.9355
24	-14.0992	174.4311	23.0884	-14.1145	-9.5219	174.7408	28.7695	-9.5266
25	-15.4618	174.3156	24.3104	-15.4820	-11.2058	174.6409	29.9408	-11.2135
26	-16.9236	174.1798	25.5533	-16.9501	-12.9837	174.5177	31.0914	-12.9956
27	-18.4863	174.0208	26.8154	-18.5209	-14.8557	174.3683	32.2227	-14.8736
28	-20.1514	173.8359	28.0952	-20.1962	-16.8217	174.1896	33.3364	-16.8477
29	-21.9201	173.6217	29.3913	-21.9778	-18.8822	173.9783	34.4338	-18.9190
30	-23.7936	173.3749	30.7024	-23.8675	-21.0377	173.7309	35.5161	-21.0887
31	-25.7728	173.0918	32.0275	-25.8669	-23.2890	173.4434	36.5845	-23.3583
32	-27.8589	172.7683	33.3656	-27.9779	-25.6369	173.1120	37.6397	-25.7295
33	-30.0528	172.4002	34.7160	-30.2025	-28.0826	172.7321	38.6826	-28.2045
34	-32.3557	171.9829	36.0782	-32.5429	-30.6271	172.2991	39.7136	-30.7856
35	-34.7687	171.5113	37.4516	-35.0016	-33.2721	171.8079	40.7333	-33.4759
36	-37.2934	170.9801	38.8360	-37.5816	-36.0192	171.2531	41.7418	-36.2785
37	-39.9317	170.3833	40.2312	-40.2866	-38.8705	170.6285	42.7393	-39.1974
38	-42.6865	169.7141	41.6373	-43.1215	-41.8292	169.9274	43.7258	-42.2381
39	-45.5619	168.9648	43.0542	-46.0930	-44.8993	169.1421	44.7010	-45.4071
40	-48.5653	168.1262	44.4823	-49.2113	-48.0880	168.2633	45.6646	-48.7147
41	-51.7152	167.1841	45.9220	-52.4991	-51.4130	167.2773	46.6157	-52.1829
42	-51.7538	167.1722	46.0440	-52.5395	-51.5819	167.2253	46.5683	-52.3596
43	-51.8216	167.1512	46.1371	-52.6105	-51.6901	167.1919	46.5384	-52.4729
44	-51.8502	167.1423	46.2502	-52.6405	-51.7790	167.1644	46.4674	-52.5659
45	-51.8352	167.1470	46.3662	-52.6247	-51.8352	167.1470	46.3662	-52.6247

X_{3D}, Y_{3D}, Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)
 X_{2D}, Z : Two-dimensional coordinate system (axial and circumferential coordinates)

付表 1.9 タービン動翼の座標 (測定位置 $N_R=2$, 半径 $R=181\text{mm}$)
 ハブ側壁面からの距離 $y=6.0\text{mm}$, スパン方向位置 $y/H=0.080$

No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-1.1110	180.9966	9.9265	-1.1110	-1.1110	180.9966	9.9265	-1.1110
2	-0.9281	180.9976	10.3304	-0.9281	-1.4946	180.9938	9.6932	-1.4946
3	-0.9202	180.9977	10.7222	-0.9202	-1.8985	180.9900	9.6428	-1.8985
4	-1.0063	180.9972	11.1813	-1.0063	-2.3920	180.9842	9.6958	-2.3921
5	-1.1725	180.9962	11.7075	-1.1725	-2.9719	180.9756	9.8526	-2.9720
6	-1.4047	180.9945	12.2973	-1.4047	-3.6302	180.9636	10.1164	-3.6304
7	-1.6867	180.9921	12.9461	-1.6867	-4.3554	180.9476	10.4921	-4.3559
8	-2.0007	180.9889	13.6480	-2.0007	-5.1332	180.9272	10.9856	-5.1339
9	-2.3274	180.9850	14.3960	-2.3274	-5.9466	180.9023	11.6039	-5.9476
10	-2.6467	180.9806	15.1816	-2.6468	-6.7749	180.8732	12.3555	-6.7765
11	-2.9532	180.9759	16.0391	-2.9533	-7.6367	180.8388	13.3013	-7.6390
12	-3.2936	180.9700	17.2719	-3.2938	-8.7628	180.7878	14.9162	-8.7662
13	-3.4788	180.9666	18.3815	-3.4790	-9.5994	180.7453	16.6546	-9.6039
14	-3.5365	180.9654	19.4011	-3.5367	-10.1390	180.7158	18.4835	-10.1443
15	-3.4894	180.9664	20.3721	-3.4896	-10.3796	180.7021	20.3611	-10.3853
16	-3.3470	180.9691	21.3379	-3.3472	-10.3317	180.7049	22.2441	-10.3373
17	-3.1060	180.9733	22.3349	-3.1062	-10.0183	180.7225	24.0963	-10.0234
18	-2.7553	180.9790	23.3864	-2.7554	-9.4695	180.7521	25.8939	-9.4738
19	-2.2832	180.9856	24.5029	-2.2833	-8.7162	180.7900	27.6268	-8.7196
20	-1.6810	180.9922	25.6849	-1.6811	-7.7857	180.8325	29.2943	-7.7881
21	-0.9450	180.9975	26.9276	-0.9450	-6.7002	180.8759	30.9012	-6.7017
22	-0.0758	181.0000	28.2239	-0.0758	-5.4769	180.9171	32.4549	-5.4778
23	0.9231	180.9976	29.5660	0.9231	-4.1299	180.9529	33.9625	-4.1303
24	2.0453	180.9884	30.9473	2.0454	-2.6706	180.9803	35.4312	-2.6707
25	3.2835	180.9702	32.3617	3.2837	-1.1088	180.9966	36.8671	-1.1088
26	4.6296	180.9408	33.8039	4.6301	0.5470	180.9992	38.2750	0.5470
27	6.0750	180.8980	35.2700	6.0762	2.2886	180.9855	39.6592	2.2887
28	7.6110	180.8399	36.7564	7.6133	4.1087	180.9534	41.0230	4.1090
29	9.2291	180.7646	38.2604	9.2331	5.9999	180.9005	42.3694	6.0010
30	10.9207	180.6703	39.7797	10.9273	7.9553	180.8251	43.7005	7.9579
31	12.6773	180.5555	41.3125	12.6877	9.9683	180.7253	45.0181	9.9733
32	14.4910	180.4190	42.8572	14.5066	12.0322	180.5996	46.3239	12.0411
33	16.3539	180.2597	44.4126	16.3763	14.1411	180.4468	47.6189	14.1555
34	18.2585	180.0767	45.9776	18.2896	16.2886	180.2656	48.9041	16.3107
35	20.1975	179.8696	47.5516	20.2397	18.4693	180.0552	50.1805	18.5015
36	22.1640	179.6378	49.1339	22.2198	20.6778	179.8150	51.4486	20.7230
37	24.1516	179.3814	50.7242	24.2238	22.9089	179.5444	52.7086	22.9705
38	26.1540	179.1004	52.3220	26.2459	25.1582	179.2430	53.9611	25.2399
39	28.1659	178.7951	53.9272	28.2809	27.4215	178.9108	55.2064	27.5275
40	30.1822	178.4658	55.5398	30.3239	29.6954	178.5474	56.4443	29.8302
41	32.1990	178.1130	57.1600	32.3713	31.9773	178.1529	57.6750	32.1460
42	32.3240	178.0903	57.2375	32.4983	32.0466	178.1404	57.7143	32.2164
43	32.3738	178.0813	57.3429	32.5490	32.1615	178.1197	57.7078	32.3332
44	32.3801	178.0801	57.4596	32.5554	32.2652	178.1010	57.6572	32.4386
45	32.3420	178.0870	57.5700	32.5166	32.3420	178.0870	57.5700	32.5166

X_{3D}, Y_{3D}, Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)
 X_{2D}, Z : Two-dimensional coordinate system (axial and circumferential coordinates)



付図 1.4 タービン静翼・動翼の配置（原寸）と設計点における速度三角形
 （測定位置 $N_R=3$, 半径 $R=184.5\text{mm}$, スパン方向位置 $y/H=0.127$ ）

付表 1.10 タービン静翼・動翼の仕様（測定位置 $N_R=3$, 半径 $R=184.5\text{mm}$ ）

		Nozzle	Rotor
Chord	C	66.43 mm	58.15 mm
Axial Chord	C_{ax}	40.85 mm	47.28 mm
Blade Pitch	S	41.40 mm	37.40 mm
Solidity	C/S	1.604	1.555
Inlet Blade Angle	α_1	0.00 deg	45.95 deg
Exit Blade Angle	α_2	70.15 deg	60.06 deg
Blade Turning Angle	$\alpha_2 - \alpha_1$	70.15 deg	106.02 deg
Stagger Angle	ξ	52.32 deg	36.27 deg
Trailing Edge Diameter	d_{TE}	0.6 mm	0.6 mm
Flow Coefficient	ϕ	0.576	
Blade Loading Coefficient	ψ	1.595	
Reaction	λ	0.202	
Nozzle / Rotor Axial Spacing	L_{NR}	25.12 mm	

付表 1.11 タービン静翼の座標 (測定位置 $N_R=3$, 半径 $R=184.5\text{mm}$)
 ハブ側壁面からの距離 $y=9.5\text{mm}$, スパン方向位置 $y/H=0.127$

No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-0.0258	184.5000	5.7580	-0.0258	-0.0258	184.5000	5.7580	-0.0258
2	-0.5196	184.4993	5.8286	-0.5196	0.4676	184.4994	5.8330	0.4676
3	-0.8708	184.4979	5.9653	-0.8708	0.8163	184.4982	5.9876	0.8163
4	-1.2078	184.4960	6.1639	-1.2078	1.1447	184.4964	6.2259	1.1448
5	-1.5374	184.4936	6.4204	-1.5374	1.4539	184.4943	6.5518	1.4539
6	-1.8627	184.4906	6.7314	-1.8627	1.7395	184.4918	6.9690	1.7395
7	-2.1869	184.4870	7.0939	-2.1870	1.9949	184.4892	7.4803	1.9949
8	-2.5130	184.4829	7.5056	-2.5131	2.2116	184.4867	8.0880	2.2117
9	-2.8445	184.4781	7.9650	-2.8447	2.3797	184.4847	8.7937	2.3797
10	-3.1854	184.4725	8.4718	-3.1856	2.4878	184.4832	9.5977	2.4878
11	-3.5597	184.4657	9.0576	-3.5600	2.5226	184.4828	10.5494	2.5227
12	-4.1244	184.4539	9.9746	-4.1247	2.4052	184.4843	12.0603	2.4052
13	-4.6842	184.4405	10.8950	-4.6847	2.1034	184.4880	13.5683	2.1034
14	-5.2609	184.4250	11.8298	-5.2616	1.6379	184.4927	15.0624	1.6379
15	-5.8705	184.4066	12.7867	-5.8714	1.0240	184.4972	16.5347	1.0240
16	-6.5257	184.3846	13.7712	-6.5271	0.2738	184.4998	17.9799	0.2738
17	-7.2374	184.3580	14.7862	-7.2392	-0.6029	184.4990	19.3951	-0.6030
18	-8.0144	184.3259	15.8330	-8.0169	-1.5982	184.4931	20.7785	-1.5982
19	-8.8641	184.2869	16.9119	-8.8675	-2.7052	184.4802	22.1302	-2.7053
20	-9.7925	184.2399	18.0223	-9.7971	-3.9189	184.4584	23.4509	-3.9192
21	-10.8049	184.1833	19.1627	-10.8110	-5.2348	184.4257	24.7415	-5.2355
22	-11.9050	184.1155	20.3315	-11.9133	-6.6500	184.3801	26.0041	-6.6514
23	-13.0964	184.0346	21.5268	-13.1075	-8.1619	184.3194	27.2402	-8.1646
24	-14.3818	183.9386	22.7467	-14.3964	-9.7687	184.2412	28.4519	-9.7733
25	-15.7629	183.8254	23.9892	-15.7822	-11.4692	184.1432	29.6409	-11.4766
26	-17.2417	183.6926	25.2526	-17.2669	-13.2624	184.0227	30.8093	-13.2738
27	-18.8195	183.5377	26.5350	-18.8522	-15.1479	183.8771	31.9585	-15.1650
28	-20.4973	183.3579	27.8350	-20.5397	-17.1256	183.7035	33.0901	-17.1502
29	-22.2759	183.1503	29.1513	-22.3304	-19.1953	183.4987	34.2056	-19.2301
30	-24.1562	182.9118	30.4824	-24.2258	-21.3573	183.2597	35.3060	-21.4053
31	-26.1386	182.6390	31.8274	-26.2269	-23.6119	182.9829	36.3927	-23.6769
32	-28.2238	182.3285	33.1854	-28.3351	-25.9596	182.6646	37.4662	-26.0460
33	-30.4121	181.9762	34.5556	-30.5516	-28.4009	182.3010	38.5275	-28.5143
34	-32.7043	181.5783	35.9375	-32.8780	-30.9365	181.8878	39.5770	-31.0833
35	-35.1007	181.1303	37.3306	-35.3160	-33.5674	181.4207	40.6152	-33.7554
36	-37.6023	180.6276	38.7346	-37.8676	-36.2945	180.8949	41.6423	-36.5328
37	-40.2101	180.0650	40.1493	-40.5354	-39.1192	180.3051	42.6586	-39.4184
38	-42.9259	179.4369	41.5749	-43.3230	-42.0438	179.6457	43.6639	-42.4165
39	-45.7527	178.7371	43.0112	-46.2351	-45.0710	178.9102	44.6580	-45.5317
40	-48.6957	177.9578	44.4587	-49.2795	-48.2062	178.0910	45.6407	-48.7723
41	-51.7697	177.0880	45.9176	-52.4743	-51.4637	177.1771	46.6112	-52.1556
42	-51.8103	177.0761	46.0430	-52.5166	-51.6298	177.1288	46.5639	-52.3286
43	-51.8768	177.0566	46.1371	-52.5858	-51.7387	177.0970	46.5358	-52.4420
44	-51.9037	177.0488	46.2506	-52.6139	-51.8289	177.0706	46.4664	-52.5360
45	-51.8868	177.0537	46.3662	-52.5963	-51.8868	177.0537	46.3662	-52.5963

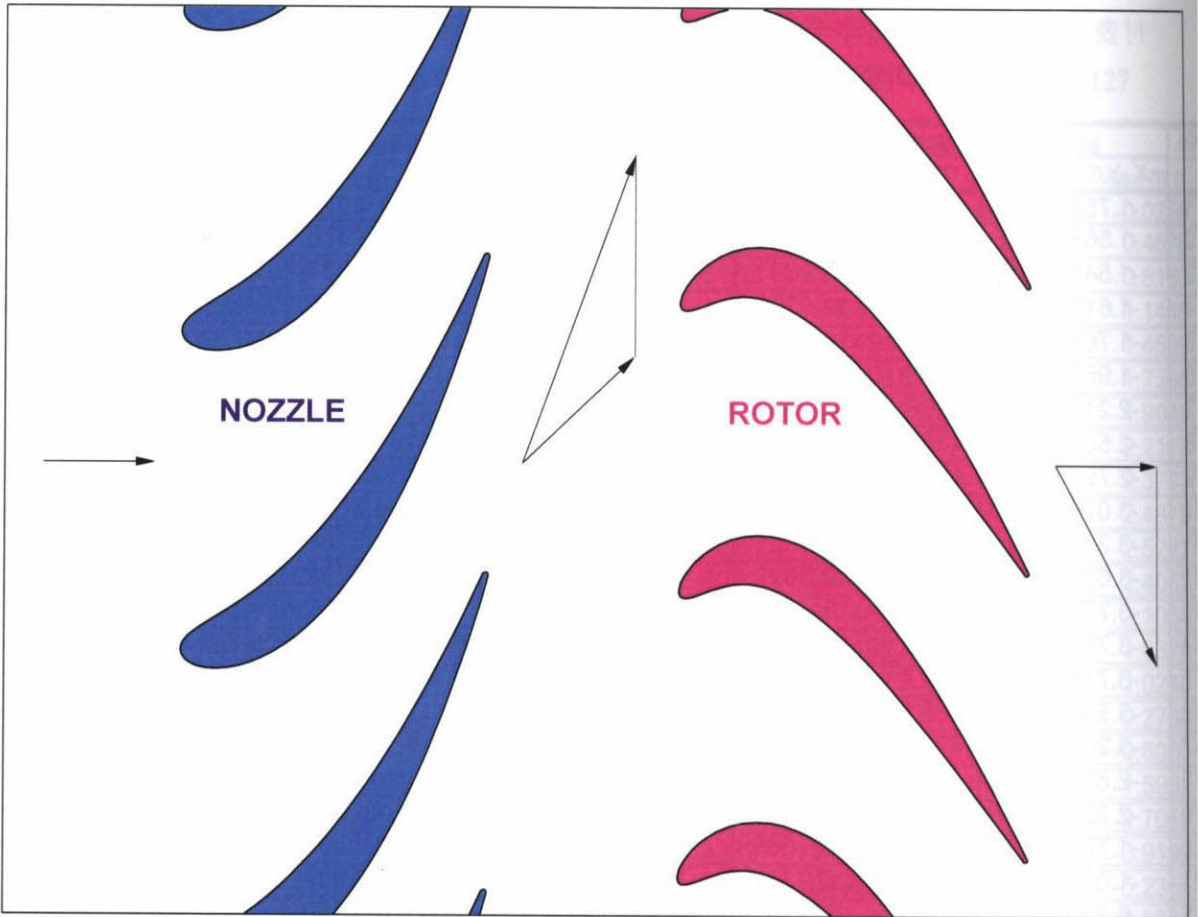
X_{3D}, Y_{3D}, Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)
 X_{2D}, Z : Two-dimensional coordinate system (axial and circumferential coordinates)

付表 1.12 タービン動翼の座標 (測定位置 $N_R=3$, 半径 $R=184.5\text{mm}$)
 ハブ側壁面からの距離 $y=9.5\text{mm}$, スパン方向位置 $y/H=0.127$

No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-1.7585	184.4916	10.2334	-1.7585	-1.7585	184.4916	10.2334	-1.7585
2	-1.5691	184.4933	10.6149	-1.5691	-2.1364	184.4876	10.0197	-2.1364
3	-1.5490	184.4935	10.9891	-1.5490	-2.5280	184.4827	9.9812	-2.5280
4	-1.6176	184.4929	11.4300	-1.6176	-3.0029	184.4756	10.0440	-3.0031
5	-1.7615	184.4916	11.9374	-1.7616	-3.5582	184.4657	10.2086	-3.5584
6	-1.9673	184.4895	12.5077	-1.9674	-4.1859	184.4525	10.4779	-4.1863
7	-2.2195	184.4866	13.1366	-2.2196	-4.8751	184.4356	10.8569	-4.8757
8	-2.5010	184.4830	13.8186	-2.5011	-5.6118	184.4146	11.3509	-5.6127
9	-2.7935	184.4789	14.5469	-2.7936	-6.3795	184.3897	11.9668	-6.3808
10	-3.0775	184.4743	15.3136	-3.0777	-7.1584	184.3611	12.7127	-7.1602
11	-3.3467	184.4696	16.1525	-3.3469	-7.9650	184.3280	13.6481	-7.9674
12	-3.6356	184.4642	17.3629	-3.6359	-9.0103	184.2799	15.2397	-9.0139
13	-3.7765	184.4613	18.4574	-3.7768	-9.7751	184.2409	16.9477	-9.7797
14	-3.7949	184.4610	19.4676	-3.7952	-10.2528	184.2149	18.7405	-10.2581
15	-3.7119	184.4627	20.4327	-3.7121	-10.4419	184.2043	20.5786	-10.4475
16	-3.5360	184.4661	21.3939	-3.5362	-10.3528	184.2093	22.4208	-10.3582
17	-3.2639	184.4711	22.3856	-3.2641	-10.0074	184.2284	24.2327	-10.0123
18	-2.8848	184.4774	23.4300	-2.8850	-9.4345	184.2586	25.9920	-9.4386
19	-2.3876	184.4846	24.5369	-2.3876	-8.6638	184.2965	27.6889	-8.6669
20	-1.7637	184.4916	25.7069	-1.7637	-7.7210	184.3384	29.3230	-7.7232
21	-1.0095	184.4972	26.9353	-1.0095	-6.6273	184.3809	30.8989	-6.6287
22	-0.1255	184.5000	28.2151	-0.1255	-5.3992	184.4210	32.4234	-5.4000
23	0.8849	184.4979	29.5392	0.8849	-4.0502	184.4555	33.9036	-4.0505
24	2.0159	184.4890	30.9010	2.0160	-2.5909	184.4818	35.3463	-2.5910
25	3.2606	184.4712	32.2949	3.2608	-1.0307	184.4971	36.7572	-1.0307
26	4.6112	184.4424	33.7157	4.6117	0.6221	184.4990	38.1411	0.6221
27	6.0597	184.4005	35.1596	6.0608	2.3599	184.4849	39.5020	2.3600
28	7.5979	184.3435	36.6233	7.6000	4.1757	184.4527	40.8431	4.1761
29	9.2176	184.2696	38.1041	9.2215	6.0626	184.4004	42.1671	6.0637
30	10.9108	184.1771	39.5998	10.9172	8.0140	184.3259	43.4764	8.0166
31	12.6696	184.0645	41.1086	12.6795	10.0236	184.2275	44.7724	10.0285
32	14.4862	183.9304	42.6291	14.5011	12.0851	184.1038	46.0568	12.0937
33	16.3533	183.7738	44.1600	16.3748	14.1928	183.9533	47.3307	14.2068
34	18.2638	183.5938	45.7005	18.2937	16.3409	183.7749	48.5949	16.3623
35	20.2107	183.3897	47.2497	20.2514	18.5240	183.5677	49.8504	18.5553
36	22.1876	183.1610	48.8071	22.2414	20.7372	183.3309	51.0977	20.7811
37	24.1883	182.9076	50.3724	24.2581	22.9755	183.0639	52.3371	23.0353
38	26.2071	182.6292	51.9451	26.2960	25.2349	182.7661	53.5689	25.3142
39	28.2387	182.3262	53.5252	28.3501	27.5113	182.4373	54.7936	27.6143
40	30.2785	181.9985	55.1126	30.4161	29.8016	182.0772	56.0110	29.9327
41	32.3230	181.6466	56.7075	32.4907	32.1036	181.6855	57.2211	32.2678
42	32.4480	181.6243	56.7828	32.6176	32.1737	181.6731	57.2613	32.3391
43	32.4985	181.6153	56.8878	32.6689	32.2886	181.6527	57.2541	32.4557
44	32.5056	181.6140	57.0045	32.6761	32.3920	181.6343	57.2027	32.5607
45	32.4682	181.6207	57.1151	32.6381	32.4682	181.6207	57.1151	32.6381

X_{3D} , Y_{3D} , Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)

X_{2D} , Z : Two-dimensional coordinate system (axial and circumferential coordinates)



付図 1.5 タービン静翼・動翼の配置（原寸）と設計点における速度三角形
 （測定位置 $N_R=4$ ，半径 $R=188\text{mm}$ ，スパン方向位置 $y/H=0.173$ ）

付表 1.13 タービン静翼・動翼の仕様（測定位置 $N_R=4$ ，半径 $R=188\text{mm}$ ）

		Nozzle	Rotor
Chord	C	66.56 mm	58.00 mm
Axial Chord	C_{ax}	41.09 mm	46.49 mm
Blade Pitch	S	42.19 mm	38.10 mm
Solidity	C/S	1.578	1.522
Inlet Blade Angle	α_1	0.00 deg	43.51 deg
Exit Blade Angle	α_2	69.81 deg	60.53 deg
Blade Turning Angle	$\alpha_2 - \alpha_1$	69.81 deg	104.04 deg
Stagger Angle	ξ	52.15 deg	37.33 deg
Trailing Edge Diameter	d_{TE}	0.6 mm	0.6 mm
Flow Coefficient	ϕ	0.565	
Blade Loading Coefficient	ψ	1.537	
Reaction	Λ	0.232	
Nozzle / Rotor Axial Spacing	L_{NR}	25.46 mm	

付表 1.14 タービン静翼の座標 (測定位置 $N_R=4$, 半径 $R=188\text{mm}$)
 ハブ側壁面からの距離 $y=13.0\text{mm}$, スパン方向位置 $y/H=0.173$

No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-0.0353	188.0000	5.5215	-0.0353	-0.0353	188.0000	5.5215	-0.0353
2	-0.5301	187.9993	5.5925	-0.5301	0.4592	187.9994	5.5969	0.4592
3	-0.8821	187.9979	5.7300	-0.8821	0.8085	187.9983	5.7524	0.8085
4	-1.2199	187.9960	5.9297	-1.2199	1.1377	187.9966	5.9922	1.1377
5	-1.5502	187.9936	6.1876	-1.5502	1.4473	187.9944	6.3201	1.4474
6	-1.8764	187.9906	6.5003	-1.8764	1.7333	187.9920	6.7397	1.7333
7	-2.2016	187.9871	6.8647	-2.2016	1.9888	187.9895	7.2541	1.9889
8	-2.5288	187.9830	7.2787	-2.5289	2.2054	187.9871	7.8655	2.2055
9	-2.8617	187.9782	7.7407	-2.8618	2.3729	187.9850	8.5754	2.3729
10	-3.2041	187.9727	8.2504	-3.2043	2.4799	187.9836	9.3841	2.4800
11	-3.5805	187.9659	8.8396	-3.5807	2.5130	187.9832	10.3413	2.5131
12	-4.1487	187.9542	9.7623	-4.1491	2.3919	187.9848	11.8606	2.3919
13	-4.7128	187.9409	10.6888	-4.7133	2.0854	187.9884	13.3767	2.0854
14	-5.2944	187.9254	11.6299	-5.2951	1.6146	187.9931	14.8785	1.6146
15	-5.9094	187.9071	12.5936	-5.9104	0.9947	187.9974	16.3581	0.9947
16	-6.5707	187.8851	13.5851	-6.5721	0.2381	187.9998	17.8104	0.2381
17	-7.2890	187.8586	14.6073	-7.2909	-0.6454	187.9989	19.2324	-0.6454
18	-8.0731	187.8266	15.6615	-8.0756	-1.6475	187.9928	20.6226	-1.6475
19	-8.9302	187.7878	16.7480	-8.9336	-2.7617	187.9797	21.9809	-2.7618
20	-9.8663	187.7409	17.8660	-9.8709	-3.9824	187.9578	23.3080	-3.9827
21	-10.8864	187.6845	19.0140	-10.8925	-5.3055	187.9251	24.6051	-5.3062
22	-11.9943	187.6170	20.1904	-12.0024	-6.7276	187.8796	25.8741	-6.7291
23	-13.1933	187.5365	21.3933	-13.2041	-8.2464	187.8191	27.1167	-8.2490
24	-14.4858	187.4411	22.6208	-14.5002	-9.8596	187.7413	28.3349	-9.8641
25	-15.8738	187.3286	23.8709	-15.8928	-11.5662	187.6439	29.5304	-11.5735
26	-17.3589	187.1969	25.1418	-17.3836	-13.3650	187.5243	30.7054	-13.3763
27	-18.9422	187.0433	26.4317	-18.9744	-15.2556	187.3800	31.8611	-15.2724
28	-20.6247	186.8653	27.7392	-20.6663	-17.2375	187.2081	32.9994	-17.2617
29	-22.4070	186.6599	29.0628	-22.4604	-19.3106	187.0056	34.1215	-19.3447
30	-24.2898	186.4243	30.4014	-24.3579	-21.4750	186.7694	35.2287	-21.5220
31	-26.2734	186.1551	31.7538	-26.3596	-23.7309	186.4962	36.3220	-23.7943
32	-28.3582	185.8489	33.1191	-28.4668	-26.0784	186.1825	37.4023	-26.1628
33	-30.5444	185.5021	34.4965	-30.6804	-28.5182	185.8244	38.4704	-28.6287
34	-32.8326	185.1108	35.8857	-33.0018	-31.0504	185.4181	39.5267	-31.1934
35	-35.2229	184.6709	37.2860	-35.4323	-33.6761	184.9592	40.5717	-33.8588
36	-37.7159	184.1779	38.6973	-37.9736	-36.3959	184.4433	41.6057	-36.6271
37	-40.3125	183.6271	40.1192	-40.6280	-39.2108	183.8655	42.6288	-39.5008
38	-43.0140	183.0131	41.5520	-43.3984	-42.1227	183.2203	43.6411	-42.4834
39	-45.8228	182.3301	42.9954	-46.2891	-45.1341	182.5018	44.6422	-45.5793
40	-48.7436	181.5711	44.4500	-49.3069	-48.2497	181.7030	45.6320	-48.7957
41	-51.7897	180.7258	45.9160	-52.4681	-51.4823	180.8136	46.6095	-52.1485
42	-51.8310	180.7140	46.0426	-52.5112	-51.6474	180.7665	46.5622	-52.3202
43	-51.8970	180.6950	46.1371	-52.5798	-51.7566	180.7353	46.5348	-52.4337
44	-51.9233	180.6875	46.2507	-52.6071	-51.8472	180.7093	46.4660	-52.5280
45	-51.9058	180.6925	46.3662	-52.5889	-51.9058	180.6925	46.3662	-52.5889

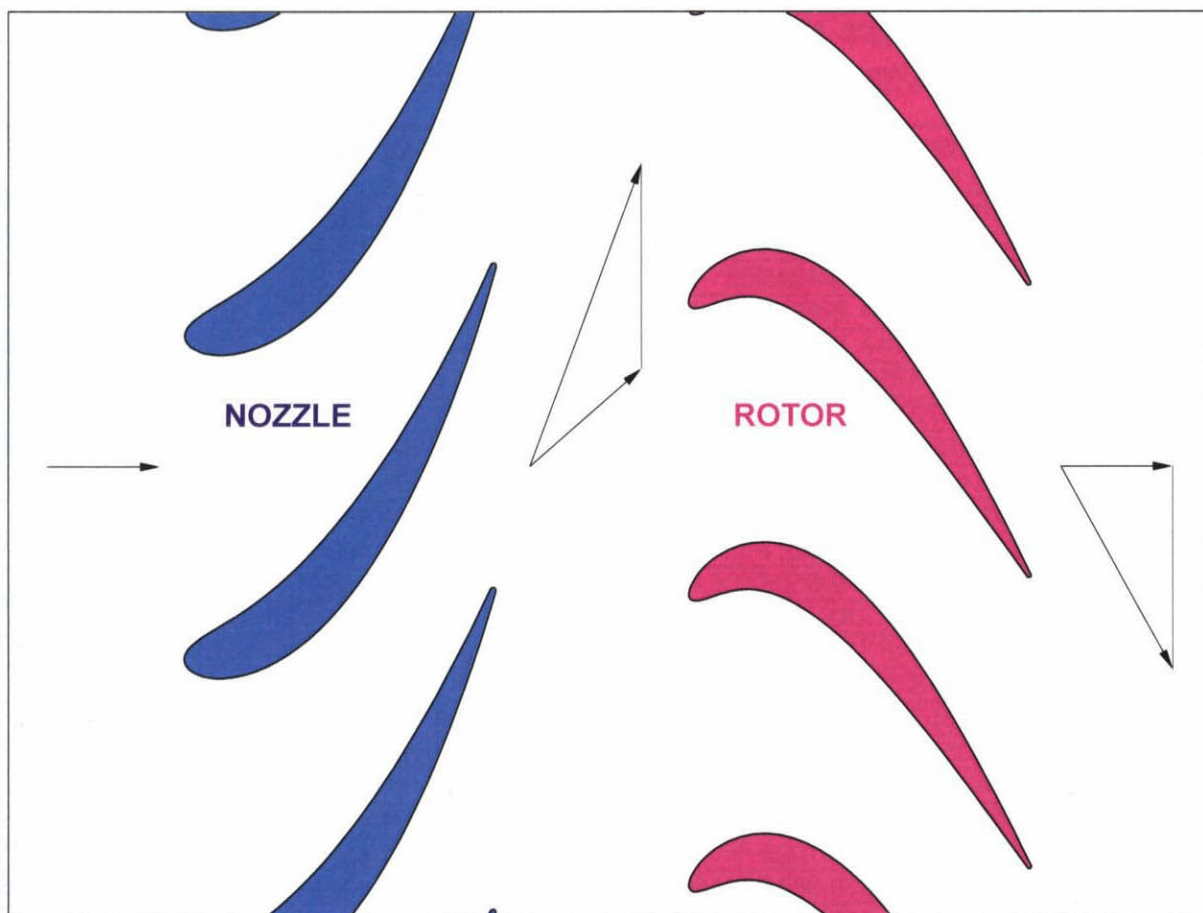
X_{3D}, Y_{3D}, Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)

X_{2D}, Z : Two-dimensional coordinate system (axial and circumferential coordinates)

付表 1.15 タービン動翼の座標 (測定位置 $N_R=4$, 半径 $R=188\text{mm}$)
 ハブ側壁面からの距離 $y=13.0\text{mm}$, スパン方向位置 $y/H=0.173$

No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-2.4056	187.9846	10.5401	-2.4057	-2.4056	187.9846	10.5401	-2.4057
2	-2.2097	187.9870	10.8993	-2.2097	-2.7778	187.9795	10.3459	-2.7779
3	-2.1775	187.9874	11.2559	-2.1775	-3.1571	187.9735	10.3195	-3.1573
4	-2.2286	187.9868	11.6786	-2.2287	-3.6136	187.9653	10.3921	-3.6138
5	-2.3503	187.9853	12.1671	-2.3504	-4.1442	187.9543	10.5644	-4.1445
6	-2.5298	187.9830	12.7180	-2.5298	-4.7415	187.9402	10.8393	-4.7420
7	-2.7522	187.9799	13.3271	-2.7523	-5.3946	187.9226	11.2215	-5.3954
8	-3.0013	187.9760	13.9891	-3.0014	-6.0903	187.9013	11.7162	-6.0913
9	-3.2595	187.9717	14.6977	-3.2596	-6.8124	187.8765	12.3298	-6.8139
10	-3.5083	187.9673	15.4455	-3.5085	-7.5419	187.8487	13.0699	-7.5439
11	-3.7402	187.9628	16.2658	-3.7404	-8.2932	187.8170	13.9949	-8.2959
12	-3.9777	187.9579	17.4539	-3.9780	-9.2578	187.7719	15.5633	-9.2616
13	-4.0742	187.9558	18.5334	-4.0745	-9.9508	187.7365	17.2408	-9.9555
14	-4.0533	187.9563	19.5342	-4.0536	-10.3666	187.7140	18.9976	-10.3718
15	-3.9343	187.9588	20.4933	-3.9346	-10.5043	187.7063	20.7961	-10.5097
16	-3.7249	187.9631	21.4499	-3.7252	-10.3738	187.7136	22.5975	-10.3791
17	-3.4217	187.9689	22.4363	-3.4219	-9.9965	187.7340	24.3692	-10.0012
18	-3.0143	187.9758	23.4736	-3.0145	-9.3996	187.7649	26.0901	-9.4035
19	-2.4919	187.9835	24.5710	-2.4920	-8.6113	187.8027	27.7511	-8.6143
20	-1.8463	187.9909	25.7289	-1.8463	-7.6562	187.8440	29.3517	-7.6583
21	-1.0739	187.9969	26.9429	-1.0739	-6.5544	187.8857	30.8965	-6.5557
22	-0.1752	187.9999	28.2063	-0.1752	-5.3216	187.9247	32.3919	-5.3223
23	0.8467	187.9981	29.5123	0.8467	-3.9704	187.9581	33.8447	-3.9707
24	1.9865	187.9895	30.8548	1.9866	-2.5112	187.9832	35.2614	-2.5113
25	3.2376	187.9721	32.2281	3.2378	-0.9527	187.9976	36.6474	-0.9527
26	4.5927	187.9439	33.6275	4.5932	0.6971	187.9987	38.0072	0.6971
27	6.0444	187.9028	35.0493	6.0454	2.4312	187.9843	39.3448	2.4313
28	7.5847	187.8469	36.4902	7.5868	4.2428	187.9521	40.6632	4.2431
29	9.2061	187.7745	37.9477	9.2098	6.1253	187.9002	41.9649	6.1264
30	10.9010	187.6837	39.4198	10.9071	8.0727	187.8266	43.2523	8.0752
31	12.6618	187.5731	40.9047	12.6714	10.0789	187.7296	44.5267	10.0837
32	14.4814	187.4414	42.4010	14.4957	12.1379	187.6078	45.7898	12.1464
33	16.3527	187.2875	43.9075	16.3734	14.2445	187.4596	47.0425	14.2582
34	18.2690	187.1102	45.4233	18.2979	16.3931	187.2839	48.2857	16.4139
35	20.2239	186.9091	46.9478	20.2631	18.5787	187.0798	49.5204	18.6090
36	22.2111	186.6833	48.4804	22.2631	20.7965	186.8462	50.7469	20.8391
37	24.2250	186.4327	50.0207	24.2926	23.0421	186.5826	51.9656	23.1002
38	26.2601	186.1569	51.5683	26.3462	25.3115	186.2883	53.1768	25.3886
39	28.3114	185.8560	53.1233	28.4196	27.6010	185.9629	54.3809	27.7011
40	30.3748	185.5300	54.6855	30.5085	29.9078	185.6058	55.5778	30.0354
41	32.4470	185.1788	56.2552	32.6103	32.2299	185.2167	56.7675	32.3899
42	32.5719	185.1569	56.3282	32.7371	32.3008	185.2044	56.8085	32.4619
43	32.6231	185.1479	56.4329	32.7891	32.4156	185.1843	56.8005	32.5784
44	32.6310	185.1465	56.5495	32.7971	32.5187	185.1662	56.7485	32.6830
45	32.5943	185.1529	56.6603	32.7598	32.5943	185.1529	56.6603	32.7598

X_{3D}, Y_{3D}, Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)
 X_{2D}, Z : Two-dimensional coordinate system (axial and circumferential coordinates)



付図 1.6 タービン静翼・動翼の配置（原寸）と設計点における速度三角形
 （測定位置 $N_R=5$, 半径 $R=191.5\text{mm}$, スパン方向位置 $y/H=0.220$ ）

付表 1.16 タービン静翼・動翼の仕様（測定位置 $N_R=5$, 半径 $R=191.5\text{mm}$ ）

		Nozzle	Rotor
Chord	C	66.69 mm	57.87 mm
Axial Chord	C_{ax}	41.32 mm	45.70 mm
Blade Pitch	S	42.97 mm	38.81 mm
Solidity	C/S	1.552	1.491
Inlet Blade Angle	α_1	0.00 deg	40.92 deg
Exit Blade Angle	α_2	69.46 deg	60.98 deg
Blade Turning Angle	$\alpha_2 - \alpha_1$	69.46 deg	101.89 deg
Stagger Angle	ξ	51.98 deg	38.39 deg
Trailing Edge Diameter	d_{TE}	0.6 mm	0.6 mm
Flow Coefficient	ϕ	0.555	
Blade Loading Coefficient	ψ	1.481	
Reaction	λ	0.260	
Nozzle / Rotor Axial Spacing	L_{NR}	25.80 mm	

付表 1.17 タービン静翼の座標 (測定位置 $N_R=5$, 半径 $R=191.5\text{mm}$)
 ハブ側壁面からの距離 $y=16.5\text{mm}$, スパン方向位置 $y/H=0.220$

No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-0.0448	191.5000	5.2850	-0.0448	-0.0448	191.5000	5.2850	-0.0448
2	-0.5407	191.4992	5.3564	-0.5407	0.4507	191.4995	5.3609	0.4507
3	-0.8934	191.4979	5.4946	-0.8934	0.8008	191.4983	5.5173	0.8008
4	-1.2320	191.4960	5.6954	-1.2320	1.1306	191.4967	5.7584	1.1306
5	-1.5631	191.4936	5.9548	-1.5631	1.4408	191.4946	6.0883	1.4408
6	-1.8901	191.4907	6.2692	-1.8901	1.7271	191.4922	6.5105	1.7272
7	-2.2162	191.4872	6.6356	-2.2163	1.9828	191.4897	7.0280	1.9828
8	-2.5446	191.4831	7.0519	-2.5447	2.1992	191.4874	7.6430	2.1992
9	-2.8788	191.4784	7.5164	-2.8789	2.3661	191.4854	8.3571	2.3662
10	-3.2228	191.4729	8.0290	-3.2230	2.4720	191.4840	9.1705	2.4721
11	-3.6012	191.4661	8.6217	-3.6014	2.5034	191.4836	10.1332	2.5035
12	-4.1731	191.4545	9.5500	-4.1734	2.3786	191.4852	11.6609	2.3786
13	-4.7414	191.4413	10.4825	-4.7419	2.0674	191.4888	13.1851	2.0675
14	-5.3278	191.4259	11.4300	-5.3285	1.5912	191.4934	14.6946	1.5912
15	-5.9483	191.4076	12.4005	-5.9493	0.9654	191.4976	16.1816	0.9654
16	-6.6157	191.3857	13.3989	-6.6170	0.2024	191.4999	17.6410	0.2024
17	-7.3407	191.3593	14.4284	-7.3425	-0.6878	191.4988	19.0698	-0.6878
18	-8.1318	191.3273	15.4901	-8.1343	-1.6969	191.4925	20.4666	-1.6969
19	-8.9963	191.2886	16.5840	-8.9997	-2.8181	191.4793	21.8315	-2.8182
20	-9.9401	191.2418	17.7096	-9.9446	-4.0459	191.4573	23.1651	-4.0462
21	-10.9680	191.1857	18.8653	-10.9740	-5.3761	191.4245	24.4687	-5.3768
22	-12.0836	191.1184	20.0494	-12.0916	-6.8053	191.3790	25.7441	-6.8067
23	-13.2901	191.0383	21.2599	-13.3008	-8.3308	191.3187	26.9932	-8.3334
24	-14.5899	190.9434	22.4950	-14.6041	-9.9505	191.2413	28.2179	-9.9550
25	-15.9848	190.8317	23.7526	-16.0034	-11.6633	191.1445	29.4199	-11.6705
26	-17.4760	190.7009	25.0310	-17.5004	-13.4677	191.0258	30.6014	-13.4788
27	-19.0649	190.5486	26.3284	-19.0965	-15.3633	190.8827	31.7638	-15.3798
28	-20.7521	190.3723	27.6434	-20.7929	-17.3494	190.7125	32.9087	-17.3732
29	-22.5381	190.1691	28.9744	-22.5904	-19.4259	190.5122	34.0375	-19.4594
30	-24.4234	189.9362	30.3204	-24.4901	-21.5927	190.2788	35.1513	-21.6387
31	-26.4081	189.6704	31.6801	-26.4925	-23.8498	190.0090	36.2514	-23.9119
32	-28.4925	189.3685	33.0527	-28.5987	-26.1972	189.6996	37.3384	-26.2796
33	-30.6767	189.0270	34.4375	-30.8094	-28.6354	189.3469	38.4133	-28.7432
34	-32.9609	188.6421	35.8340	-33.1258	-31.1643	188.9472	39.4764	-31.3035
35	-35.3450	188.2099	37.2415	-35.5489	-33.7847	188.4963	40.5283	-33.9625
36	-37.8295	187.7263	38.6600	-38.0800	-36.4971	187.9899	41.5691	-36.7218
37	-40.4148	187.1868	40.0891	-40.7210	-39.3022	187.4235	42.5992	-39.5835
38	-43.1020	186.5864	41.5290	-43.4745	-42.2016	186.7921	43.6183	-42.5509
39	-45.8929	185.9196	42.9797	-46.3439	-45.1972	186.0899	44.6264	-45.6277
40	-48.7914	185.1800	44.4413	-49.3354	-48.2931	185.3106	45.6232	-48.8202
41	-51.8096	184.3584	45.9144	-52.4635	-51.5009	184.4449	46.6079	-52.1428
42	-51.8518	184.3465	46.0422	-52.5072	-51.6650	184.3990	46.5606	-52.3132
43	-51.9173	184.3281	46.1371	-52.5752	-51.7744	184.3683	46.5339	-52.4268
44	-51.9429	184.3209	46.2508	-52.6019	-51.8655	184.3427	46.4656	-52.5215
45	-51.9247	184.3260	46.3662	-52.5830	-51.9247	184.3260	46.3662	-52.5830

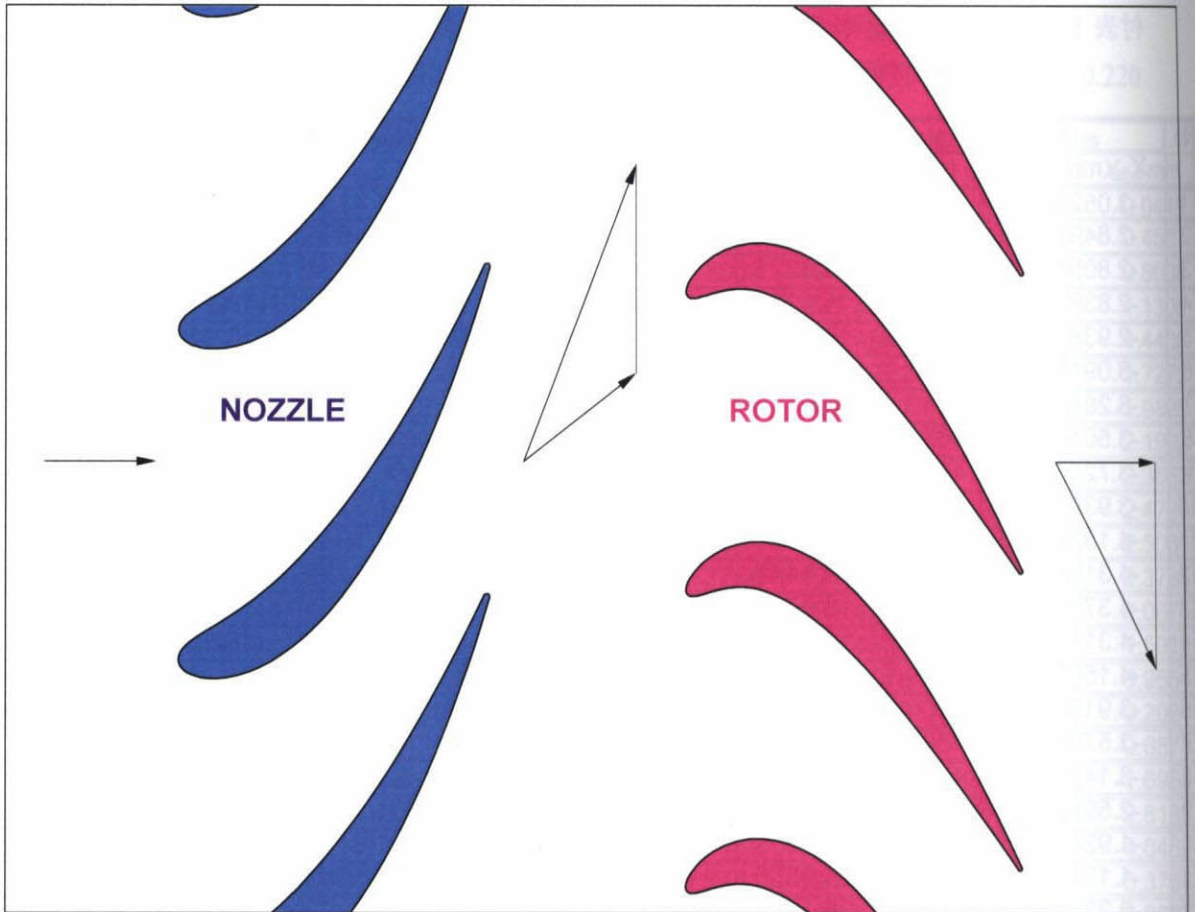
X_{3D}, Y_{3D}, Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)
 X_{2D}, Z : Two-dimensional coordinate system (axial and circumferential coordinates)

付表 1.18 タービン動翼の座標 (測定位置 $N_R=5$, 半径 $R=191.5\text{mm}$)
 ハブ側壁面からの距離 $y=16.5\text{mm}$, スパン方向位置 $y/H=0.220$

No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-3.0524	191.4757	10.8466	-3.0525	-3.0524	191.4757	10.8466	-3.0525
2	-2.8499	191.4788	11.1834	-2.8500	-3.4188	191.4695	10.6720	-3.4190
3	-2.8056	191.4794	11.5225	-2.8057	-3.7860	191.4626	10.6576	-3.7862
4	-2.8393	191.4789	11.9271	-2.8394	-4.2240	191.4534	10.7400	-4.2243
5	-2.9389	191.4774	12.3968	-2.9390	-4.7300	191.4416	10.9200	-4.7305
6	-3.0919	191.4750	12.9282	-3.0921	-5.2968	191.4267	11.2006	-5.2975
7	-3.2846	191.4718	13.5175	-3.2848	-5.9140	191.4087	11.5860	-5.9150
8	-3.5013	191.4680	14.1596	-3.5015	-6.5686	191.3873	12.0813	-6.5699
9	-3.7253	191.4638	14.8486	-3.7256	-7.2452	191.3629	12.6926	-7.2469
10	-3.9390	191.4595	15.5773	-3.9393	-7.9253	191.3359	13.4270	-7.9276
11	-4.1336	191.4554	16.3791	-4.1339	-8.6214	191.3058	14.3417	-8.6243
12	-4.3196	191.4513	17.5448	-4.3200	-9.5053	191.2639	15.8869	-9.5092
13	-4.3719	191.4501	18.6093	-4.3723	-10.1265	191.2321	17.5339	-10.1312
14	-4.3117	191.4515	19.6007	-4.3121	-10.4804	191.2130	19.2546	-10.4856
15	-4.1567	191.4549	20.5539	-4.1570	-10.5666	191.2083	21.0136	-10.5719
16	-3.9139	191.4600	21.5058	-3.9141	-10.3949	191.2177	22.7741	-10.4000
17	-3.5796	191.4665	22.4870	-3.5798	-9.9855	191.2395	24.5056	-9.9901
18	-3.1439	191.4742	23.5172	-3.1440	-9.3646	191.2709	26.1882	-9.3684
19	-2.5962	191.4824	24.6050	-2.5963	-8.5588	191.3086	27.8132	-8.5617
20	-1.9289	191.4903	25.7509	-1.9289	-7.5914	191.3495	29.3804	-7.5934
21	-1.1384	191.4966	26.9505	-1.1384	-6.4815	191.3903	30.8941	-6.4827
22	-0.2249	191.4999	28.1975	-0.2249	-5.2439	191.4282	32.3605	-5.2445
23	0.8086	191.4983	29.4855	0.8086	-3.8906	191.4605	33.7858	-3.8909
24	1.9572	191.4900	30.8085	1.9572	-2.4315	191.4846	35.1765	-2.4315
25	3.2147	191.4730	32.1613	3.2148	-0.8747	191.4980	36.5375	-0.8747
26	4.5743	191.4454	33.5392	4.5748	0.7722	191.4984	37.8733	0.7722
27	6.0291	191.4051	34.9389	6.0301	2.5025	191.4836	39.1876	2.5026
28	7.5716	191.3503	36.3570	7.5736	4.3098	191.4515	40.4832	4.3102
29	9.1947	191.2791	37.7914	9.1982	6.1881	191.4000	41.7627	6.1892
30	10.8912	191.1900	39.2399	10.8970	8.1314	191.3273	43.0282	8.1339
31	12.6541	191.0815	40.7008	12.6633	10.1341	191.2317	44.2810	10.1389
32	14.4766	190.9520	42.1729	14.4904	12.1908	191.1116	45.5227	12.1990
33	16.3521	190.8006	43.6550	16.3720	14.2962	190.9656	46.7543	14.3095
34	18.2743	190.6261	45.1463	18.3021	16.4453	190.7926	47.9766	16.4656
35	20.2371	190.4277	46.6460	20.2750	18.6333	190.5913	49.1904	18.6629
36	22.2347	190.2048	48.1537	22.2850	20.8558	190.3609	50.3961	20.8973
37	24.2617	189.9569	49.6690	24.3271	23.1086	190.1006	51.5942	23.1651
38	26.3130	189.6836	51.1916	26.3966	25.3881	189.8096	52.7848	25.4630
39	28.3842	189.3848	52.7215	28.4891	27.6907	189.4874	53.9684	27.7881
40	30.4711	189.0602	54.2586	30.6011	30.0139	189.1333	55.1447	30.1382
41	32.5709	188.7098	55.8031	32.7300	32.3561	188.7467	56.3140	32.5121
42	32.6957	188.6882	55.8739	32.8567	32.4279	188.7344	56.3559	32.5849
43	32.7476	188.6792	55.9781	32.9094	32.5426	188.7147	56.3470	32.7013
44	32.7563	188.6777	56.0946	32.9182	32.6453	188.6969	56.2943	32.8055
45	32.7204	188.6839	56.2057	32.8817	32.7204	188.6839	56.2057	32.8817

X_{3D} , Y_{3D} , Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)

X_{2D} , Z : Two-dimensional coordinate system (axial and circumferential coordinates)



付図 1.7 タービン静翼・動翼の配置（原寸）と設計点における速度三角形（測定位置 $N_R=6$ ，半径 $R=194\text{mm}$ ，スパン方向位置 $y/H=0.253$ ）

付表 1.19 タービン静翼・動翼の仕様（測定位置 $N_R=6$ ，半径 $R=194\text{mm}$ ）

		Nozzle	Rotor
Chord	C	66.83 mm	57.76 mm
Axial Chord	C_{ax}	41.56 mm	44.91 mm
Blade Pitch	S	43.76 mm	39.52 mm
Solidity	C/S	1.527	1.461
Inlet Blade Angle	α_1	0.00 deg	38.16 deg
Exit Blade Angle	α_2	69.12 deg	61.42 deg
Blade Turning Angle	$\alpha_2 - \alpha_1$	69.12 deg	99.58 deg
Stagger Angle	ξ	51.81 deg	39.45 deg
Trailing Edge Diameter	d_{TE}	0.6 mm	0.6 mm
Flow Coefficient	ϕ	0.545	
Blade Loading Coefficient	ψ	1.428	
Reaction	Λ	0.286	
Nozzle / Rotor Axial Spacing	L_{NR}	26.13 mm	

付表 1.20 タービン静翼の座標 (測定位置 $N_R=6$, 半径 $R=194\text{mm}$)
 ハブ側壁面からの距離 $y=19.0\text{mm}$, スパン方向位置 $y/H=0.253$

No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-0.0543	195.0000	5.0485	-0.0543	-0.0543	195.0000	5.0485	-0.0543
2	-0.5512	194.9992	5.1203	-0.5512	0.4423	194.9995	5.1248	0.4423
3	-0.9047	194.9979	5.2593	-0.9047	0.7931	194.9984	5.2821	0.7931
4	-1.2440	194.9960	5.4612	-1.2440	1.1235	194.9968	5.5247	1.1235
5	-1.5759	194.9936	5.7220	-1.5759	1.4342	194.9947	5.8565	1.4342
6	-1.9038	194.9907	6.0381	-1.9038	1.7209	194.9924	6.2812	1.7210
7	-2.2309	194.9872	6.4065	-2.2310	1.9767	194.9900	6.8018	1.9768
8	-2.5604	194.9832	6.8250	-2.5605	2.1930	194.9877	7.4205	2.1930
9	-2.8959	194.9785	7.2921	-2.8960	2.3593	194.9857	8.1388	2.3594
10	-3.2415	194.9731	7.8076	-3.2417	2.4642	194.9844	8.9570	2.4643
11	-3.6219	194.9664	8.4037	-3.6221	2.4938	194.9841	9.9251	2.4939
12	-4.1974	194.9548	9.3377	-4.1977	2.3652	194.9857	11.4612	2.3653
13	-4.7700	194.9417	10.2763	-4.7704	2.0495	194.9892	12.9934	2.0495
14	-5.3612	194.9263	11.2302	-5.3619	1.5679	194.9937	14.5106	1.5679
15	-5.9872	194.9081	12.2073	-5.9882	0.9361	194.9978	16.0050	0.9361
16	-6.6607	194.8862	13.2128	-6.6620	0.1666	194.9999	17.4715	0.1666
17	-7.3923	194.8598	14.2495	-7.3941	-0.7302	194.9986	18.9072	-0.7302
18	-8.1906	194.8279	15.3186	-8.1930	-1.7462	194.9922	20.3107	-1.7463
19	-9.0625	194.7893	16.4201	-9.0658	-2.8745	194.9788	21.6821	-2.8746
20	-10.0139	194.7427	17.5533	-10.0183	-4.1095	194.9567	23.0222	-4.1098
21	-11.0495	194.6867	18.7166	-11.0554	-5.4468	194.9239	24.3323	-5.4475
22	-12.1728	194.6197	19.9083	-12.1807	-6.8829	194.8785	25.6142	-6.8843
23	-13.3869	194.5399	21.1264	-13.3975	-8.4152	194.8183	26.8697	-8.4178
24	-14.6940	194.4456	22.3691	-14.7080	-10.0415	194.7413	28.1009	-10.0459
25	-16.0957	194.3346	23.6343	-16.1140	-11.7603	194.6451	29.3095	-11.7674
26	-17.5932	194.2047	24.9203	-17.6172	-13.5703	194.5272	30.4975	-13.5813
27	-19.1876	194.0537	26.2252	-19.2187	-15.4709	194.3853	31.6665	-15.4872
28	-20.8794	193.8790	27.5476	-20.9195	-17.4613	194.2166	32.8180	-17.4847
29	-22.6691	193.6779	28.8861	-22.7205	-19.5413	194.0184	33.9535	-19.5741
30	-24.5569	193.4476	30.2394	-24.6223	-21.7104	193.7877	35.0740	-21.7555
31	-26.5427	193.1851	31.6064	-26.6254	-23.9687	193.5213	36.1808	-24.0294
32	-28.6268	192.8873	32.9864	-28.7306	-26.3160	193.2161	37.2746	-26.3965
33	-30.8089	192.5508	34.3785	-30.9386	-28.7525	192.8686	38.3562	-28.8577
34	-33.0891	192.1721	35.7822	-33.2500	-31.2781	192.4751	39.4261	-31.4138
35	-35.4671	191.7474	37.1970	-35.6656	-33.8933	192.0319	40.4848	-34.0664
36	-37.9431	191.2729	38.6227	-38.1867	-36.5983	191.5348	41.5326	-36.8167
37	-40.5171	190.7442	40.0590	-40.8144	-39.3936	190.9794	42.5695	-39.6666
38	-43.1899	190.1569	41.5061	-43.5511	-42.2804	190.3611	43.5956	-42.6189
39	-45.9629	189.5057	42.9639	-46.3995	-45.2602	189.6748	44.6107	-45.6767
40	-48.8392	188.7849	44.4327	-49.3648	-48.3364	188.9142	45.6145	-48.8456
41	-51.8296	187.9859	45.9128	-52.4601	-51.5195	188.0711	46.6062	-52.1385
42	-51.8725	187.9741	46.0418	-52.5046	-51.6826	188.0264	46.5590	-52.3076
43	-51.9375	187.9561	46.1371	-52.5720	-51.7922	187.9962	46.5329	-52.4213
44	-51.9625	187.9492	46.2510	-52.5979	-51.8838	187.9709	46.4652	-52.5164
45	-51.9436	187.9544	46.3662	-52.5784	-51.9436	187.9544	46.3662	-52.5784

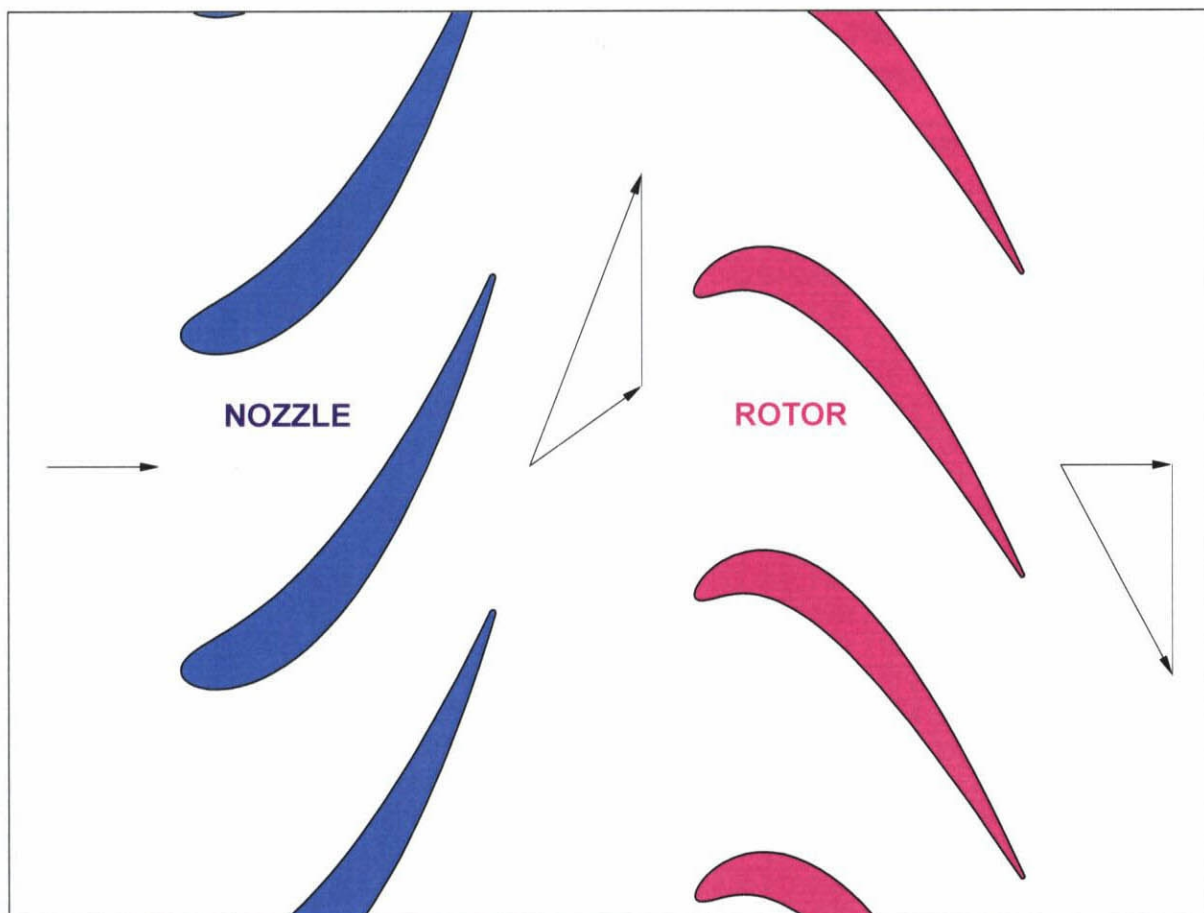
X_{3D} , Y_{3D} , Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)

X_{2D} , Z : Two-dimensional coordinate system (axial and circumferential coordinates)

付表 1.21 タービン動翼の座標 (測定位置 $N_R=6$, 半径 $R=194\text{mm}$)
 ハブ側壁面からの距離 $y=19.0\text{mm}$, スパン方向位置 $y/H=0.253$

No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-3.6988	194.9649	11.1529	-3.6991	-3.6988	194.9649	11.1529	-3.6991
2	-3.4898	194.9688	11.4675	-3.4900	-4.0595	194.9577	10.9979	-4.0598
3	-3.4334	194.9698	11.7890	-3.4336	-4.4146	194.9500	10.9955	-4.4149
4	-3.4498	194.9695	12.1755	-3.4499	-4.8341	194.9401	11.0878	-4.8346
5	-3.5271	194.9681	12.6263	-3.5273	-5.3156	194.9275	11.2756	-5.3163
6	-3.6539	194.9658	13.1384	-3.6541	-5.8520	194.9122	11.5617	-5.8529
7	-3.8169	194.9626	13.7079	-3.8171	-6.4333	194.8939	11.9505	-6.4344
8	-4.0012	194.9589	14.3301	-4.0015	-7.0469	194.8726	12.4465	-7.0484
9	-4.1911	194.9550	14.9994	-4.1914	-7.6779	194.8488	13.0554	-7.6799
10	-4.3696	194.9510	15.7092	-4.3700	-8.3087	194.8229	13.7841	-8.3113
11	-4.5269	194.9474	16.4924	-4.5273	-8.9496	194.7945	14.6885	-8.9527
12	-4.6616	194.9443	17.6358	-4.6620	-9.7528	194.7560	16.2104	-9.7569
13	-4.6696	194.9441	18.6852	-4.6700	-10.3022	194.7277	17.8270	-10.3070
14	-4.5701	194.9464	19.6672	-4.5705	-10.5942	194.7120	19.5116	-10.5994
15	-4.3791	194.9508	20.6145	-4.3795	-10.6289	194.7101	21.2311	-10.6342
16	-4.1028	194.9568	21.5618	-4.1031	-10.4159	194.7216	22.9508	-10.4209
17	-3.7374	194.9642	22.5377	-3.7377	-9.9746	194.7447	24.6421	-9.9790
18	-3.2734	194.9725	23.5608	-3.2735	-9.3297	194.7767	26.2863	-9.3333
19	-2.7006	194.9813	24.6391	-2.7006	-8.5063	194.8144	27.8754	-8.5090
20	-2.0115	194.9896	25.7729	-2.0116	-7.5267	194.8547	29.4092	-7.5285
21	-1.2029	194.9963	26.9581	-1.2029	-6.4086	194.8947	30.8918	-6.4097
22	-0.2747	194.9998	28.1887	-0.2747	-5.1662	194.9316	32.3290	-5.1668
23	0.7704	194.9985	29.4587	0.7704	-3.8109	194.9628	33.7270	-3.8111
24	1.9278	194.9905	30.7622	1.9278	-2.3517	194.9858	35.0916	-2.3518
25	3.1917	194.9739	32.0945	3.1918	-0.7967	194.9984	36.4277	-0.7967
26	4.5559	194.9468	33.4510	4.5563	0.8473	194.9982	37.7394	0.8473
27	6.0137	194.9072	34.8285	6.0147	2.5738	194.9830	39.0304	2.5739
28	7.5584	194.8535	36.2239	7.5603	4.3769	194.9509	40.3033	4.3773
29	9.1832	194.7836	37.6350	9.1866	6.2508	194.8998	41.5605	6.2519
30	10.8813	194.6962	39.0599	10.8870	8.1901	194.8279	42.8041	8.1925
31	12.6463	194.5895	40.4970	12.6552	10.1894	194.7336	44.0353	10.1941
32	14.4717	194.4623	41.9449	14.4851	12.2436	194.6152	45.2557	12.2517
33	16.3515	194.3132	43.4026	16.3707	14.3479	194.4714	46.4661	14.3609
34	18.2795	194.1413	44.8693	18.3064	16.4975	194.3009	47.6675	16.5172
35	20.2503	193.9457	46.3443	20.2869	18.6880	194.1024	48.8604	18.7167
36	22.2582	193.7255	47.8271	22.3069	20.9152	193.8751	50.0454	20.9555
37	24.2984	193.4802	49.3175	24.3617	23.1752	193.6179	51.2228	23.2301
38	26.3660	193.2093	50.8151	26.4470	25.4647	193.3302	52.3929	25.5376
39	28.4569	192.9124	52.3199	28.5589	27.7804	193.0110	53.5559	27.8752
40	30.5673	192.5893	53.8318	30.6939	30.1200	192.6598	54.7118	30.2411
41	32.6948	192.2396	55.3512	32.8499	32.4823	192.2756	55.8606	32.6344
42	32.8195	192.2183	55.4197	32.9765	32.5549	192.2633	55.9034	32.7080
43	32.8722	192.2093	55.5236	33.0299	32.6696	192.2438	55.8938	32.8244
44	32.8816	192.2077	55.6399	33.0395	32.7719	192.2264	55.8404	32.9282
45	32.8464	192.2137	55.7512	33.0038	32.8464	192.2137	55.7512	33.0038

X_{3D}, Y_{3D}, Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)
 X_{2D}, Z : Two-dimensional coordinate system (axial and circumferential coordinates)



付図 1.8 タービン静翼・動翼の配置（原寸）と設計点における速度三角形
 （測定位置 $N_R=7$, 半径 $R=197.5\text{mm}$, スパン方向位置 $y/H=0.300$ ）

付表 1.22 タービン静翼・動翼の仕様（測定位置 $N_R=7$, 半径 $R=197.5\text{mm}$ ）

		Nozzle	Rotor
Chord	C	66.96 mm	57.67 mm
Axial Chord	C_{ax}	41.79 mm	44.13 mm
Blade Pitch	S	44.54 mm	40.23 mm
Solidity	C/S	1.503	1.433
Inlet Blade Angle	α_1	0.00 deg	35.25 deg
Exit Blade Angle	α_2	68.78 deg	61.84 deg
Blade Turning Angle	$\alpha_2 - \alpha_1$	68.78 deg	97.09 deg
Stagger Angle	ξ	51.64 deg	40.52 deg
Trailing Edge Diameter	d_{TE}	0.6 mm	0.6 mm
Flow Coefficient	ϕ	0.535	
Blade Loading Coefficient	ψ	1.378	
Reaction	λ	0.311	
Nozzle / Rotor Axial Spacing	L_{NR}	26.46 mm	

付表 1.23 タービン静翼の座標 (測定位置 $N_R=7$, 半径 $R=197.5\text{mm}$)
 ハブ側壁面からの距離 $y=22.5\text{mm}$, スパン方向位置 $y/H=0.300$

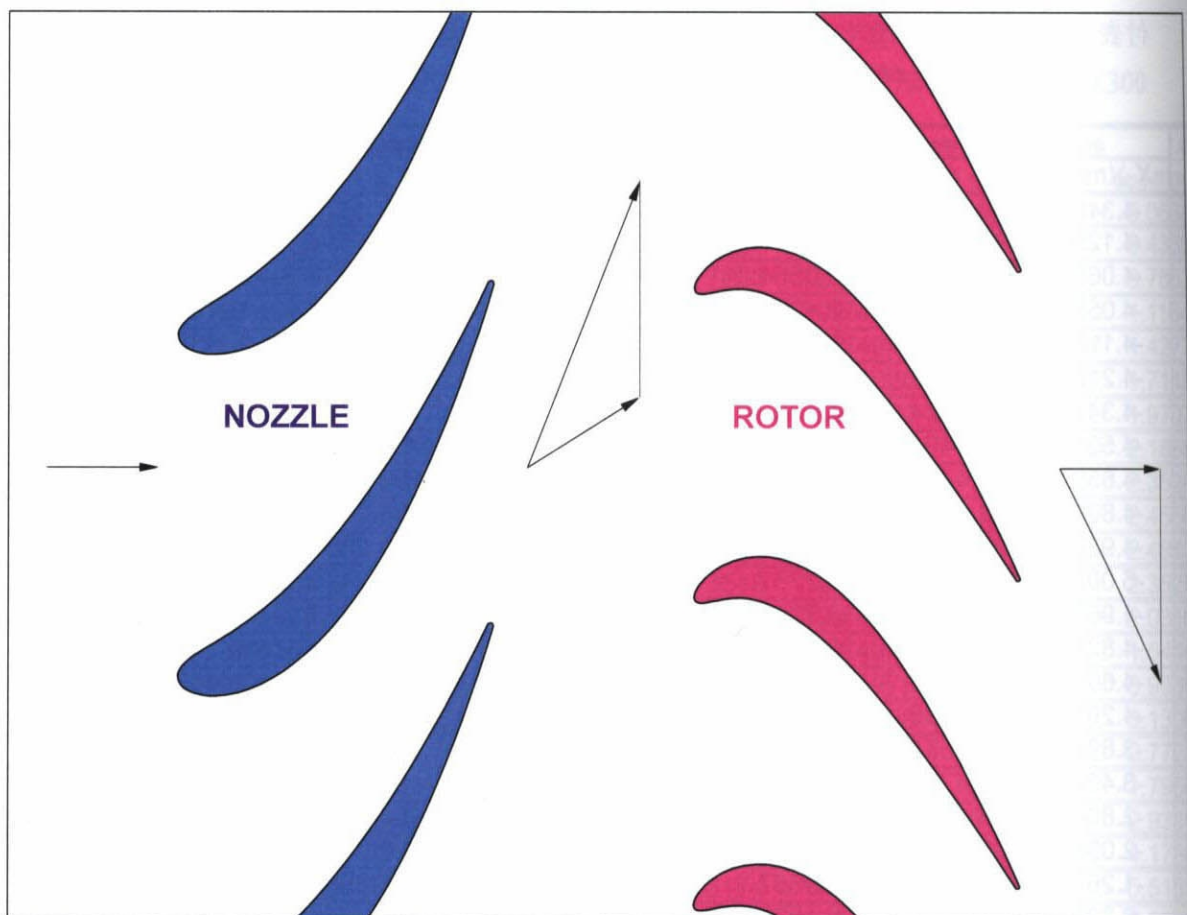
No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-0.0638	198.5000	4.8119	-0.0638	-0.0638	198.5000	4.8119	-0.0638
2	-0.5618	198.4992	4.8842	-0.5618	0.4338	198.4995	4.8887	0.4338
3	-0.9160	198.4979	5.0240	-0.9160	0.7853	198.4984	5.0469	0.7853
4	-1.2561	198.4960	5.2270	-1.2561	1.1164	198.4969	5.2910	1.1164
5	-1.5887	198.4936	5.4892	-1.5888	1.4277	198.4949	5.6248	1.4277
6	-1.9175	198.4907	5.8069	-1.9175	1.7148	198.4926	6.0520	1.7148
7	-2.2456	198.4873	6.1773	-2.2456	1.9707	198.4902	6.5757	1.9707
8	-2.5762	198.4833	6.5981	-2.5763	2.1868	198.4880	7.1980	2.1868
9	-2.9130	198.4786	7.0678	-2.9131	2.3525	198.4861	7.9205	2.3526
10	-3.2602	198.4732	7.5862	-3.2604	2.4563	198.4848	8.7434	2.4564
11	-3.6426	198.4666	8.1857	-3.6428	2.4842	198.4845	9.7170	2.4843
12	-4.2218	198.4551	9.1255	-4.2221	2.3519	198.4861	11.2615	2.3520
13	-4.7985	198.4420	10.0700	-4.7990	2.0315	198.4896	12.8018	2.0316
14	-5.3946	198.4267	11.0303	-5.3953	1.5445	198.4940	14.3267	1.5445
15	-6.0262	198.4085	12.0142	-6.0271	0.9068	198.4979	15.8285	0.9068
16	-6.7058	198.3867	13.0267	-6.7070	0.1309	198.5000	17.3020	0.1309
17	-7.4440	198.3604	14.0706	-7.4457	-0.7726	198.4985	18.7445	-0.7726
18	-8.2493	198.3285	15.1471	-8.2517	-1.7956	198.4919	20.1547	-1.7956
19	-9.1286	198.2900	16.2562	-9.1319	-2.9309	198.4784	21.5327	-2.9310
20	-10.0877	198.2435	17.3969	-10.0921	-4.1730	198.4561	22.8793	-4.1733
21	-11.1310	198.1877	18.5679	-11.1369	-5.5174	198.4233	24.1959	-5.5181
22	-12.2621	198.1209	19.7672	-12.2699	-6.9605	198.3779	25.4842	-6.9619
23	-13.4837	198.0415	20.9930	-13.4941	-8.4996	198.3179	26.7462	-8.5022
24	-14.7981	197.9476	22.2432	-14.8118	-10.1324	198.2412	27.9839	-10.1368
25	-16.2066	197.8373	23.5160	-16.2246	-11.8573	198.1455	29.1990	-11.8644
26	-17.7104	197.7084	24.8095	-17.7339	-13.6730	198.0285	30.3936	-13.6838
27	-19.3103	197.5585	26.1219	-19.3409	-15.5786	197.8877	31.5691	-15.5946
28	-21.0068	197.3853	27.4518	-21.0462	-17.5732	197.7206	32.7273	-17.5963
29	-22.8001	197.1862	28.7977	-22.8506	-19.6566	197.5244	33.8694	-19.6888
30	-24.6904	196.9585	30.1584	-24.7545	-21.8281	197.2962	34.9966	-21.8723
31	-26.6774	196.6992	31.5328	-26.7583	-24.0875	197.0331	36.1102	-24.1471
32	-28.7611	196.4053	32.9201	-28.8627	-26.4347	196.7319	37.2107	-26.5135
33	-30.9411	196.0737	34.3195	-31.0678	-28.8696	196.3894	38.2991	-28.9724
34	-33.2173	195.7009	35.7305	-33.3743	-31.3920	196.0020	39.3758	-31.5243
35	-35.5892	195.2835	37.1525	-35.7827	-34.0019	195.5662	40.4414	-34.1704
36	-38.0566	194.8177	38.5854	-38.2936	-36.6995	195.0779	41.4960	-36.9119
37	-40.6193	194.2996	40.0289	-40.9083	-39.4850	194.5332	42.5398	-39.7501
38	-43.2778	193.7248	41.4832	-43.6282	-42.3592	193.9277	43.5729	-42.6874
39	-46.0328	193.0887	42.9481	-46.4557	-45.3231	193.2565	44.5949	-45.7265
40	-48.8870	192.3858	44.4240	-49.3952	-48.3797	192.5140	45.6057	-48.8720
41	-51.8495	191.6087	45.9112	-52.4580	-51.5380	191.6927	46.6046	-52.1354
42	-51.8931	191.5969	46.0414	-52.5032	-51.7001	191.6490	46.5573	-52.3032
43	-51.9576	191.5794	46.1371	-52.5700	-51.8100	191.6193	46.5320	-52.4170
44	-51.9820	191.5728	46.2511	-52.5953	-51.9021	191.5944	46.4648	-52.5124
45	-51.9625	191.5781	46.3662	-52.5750	-51.9625	191.5781	46.3662	-52.5750

X_{3D} , Y_{3D} , Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)
 X_{2D} , Z : Two-dimensional coordinate system (axial and circumferential coordinates)

付表 1.24 タービン動翼の座標 (測定位置 $N_R=7$, 半径 $R=197.5\text{mm}$)
 ハブ側壁面からの距離 $y=22.5\text{mm}$, スパン方向位置 $y/H=0.300$

No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-4.3450	198.4524	11.4591	-4.3453	-4.3450	198.4524	11.4591	-4.3453
2	-4.1294	198.4570	11.7514	-4.1297	-4.7000	198.4444	11.3236	-4.7004
3	-4.0609	198.4585	12.0554	-4.0612	-5.0429	198.4359	11.3333	-5.0434
4	-4.0599	198.4585	12.4237	-4.0602	-5.4440	198.4253	11.4354	-5.4447
5	-4.1152	198.4573	12.8558	-4.1155	-5.9010	198.4123	11.6310	-5.9019
6	-4.2157	198.4552	13.3485	-4.2160	-6.4070	198.3966	11.9228	-6.4081
7	-4.3490	198.4524	13.8982	-4.3493	-6.9524	198.3782	12.3148	-6.9538
8	-4.5010	198.4490	14.5005	-4.5014	-7.5251	198.3573	12.8115	-7.5269
9	-4.6567	198.4454	15.1501	-4.6572	-8.1106	198.3342	13.4182	-8.1129
10	-4.8001	198.4420	15.8410	-4.8006	-8.6921	198.3096	14.1412	-8.6949
11	-4.9202	198.4390	16.6056	-4.9207	-9.2778	198.2831	15.0353	-9.2812
12	-5.0035	198.4369	17.7267	-5.0040	-10.0003	198.2479	16.5340	-10.0046
13	-4.9672	198.4378	18.7611	-4.9677	-10.4779	198.2233	18.1201	-10.4828
14	-4.8284	198.4413	19.7337	-4.8289	-10.7079	198.2110	19.7687	-10.7131
15	-4.6015	198.4467	20.6751	-4.6019	-10.6912	198.2119	21.4486	-10.6964
16	-4.2917	198.4536	21.6177	-4.2921	-10.4370	198.2254	23.1275	-10.4418
17	-3.8953	198.4618	22.5884	-3.8955	-9.9637	198.2498	24.7785	-9.9679
18	-3.4029	198.4708	23.6044	-3.4030	-9.2948	198.2823	26.3843	-9.2982
19	-2.8049	198.4802	24.6731	-2.8050	-8.4539	198.3199	27.9375	-8.4564
20	-2.0941	198.4890	25.7948	-2.0942	-7.4619	198.3597	29.4379	-7.4637
21	-1.2673	198.4960	26.9657	-1.2673	-6.3357	198.3989	30.8894	-6.3368
22	-0.3244	198.4997	28.1800	-0.3244	-5.0885	198.4348	32.2975	-5.0891
23	0.7322	198.4986	29.4318	0.7322	-3.7311	198.4649	33.6681	-3.7313
24	1.8984	198.4909	30.7160	1.8984	-2.2720	198.4870	35.0067	-2.2721
25	3.1687	198.4747	32.0277	3.1689	-0.7187	198.4987	36.3178	-0.7187
26	4.5375	198.4481	33.3628	4.5379	0.9223	198.4979	37.6056	0.9223
27	5.9984	198.4093	34.7181	5.9993	2.6451	198.4824	38.8732	2.6452
28	7.5453	198.3565	36.0908	7.5471	4.4439	198.4502	40.1233	4.4443
29	9.1717	198.2880	37.4787	9.1750	6.3136	198.3996	41.3583	6.3146
30	10.8715	198.2021	38.8800	10.8770	8.2488	198.3285	42.5800	8.2512
31	12.6386	198.0972	40.2931	12.6471	10.2447	198.2355	43.7896	10.2492
32	14.4669	197.9721	41.7168	14.4798	12.2964	198.1188	44.9887	12.3043
33	16.3508	197.8254	43.1502	16.3694	14.3996	197.9770	46.1780	14.4123
34	18.2848	197.6561	44.5923	18.3107	16.5497	197.8089	47.3584	16.5689
35	20.2635	197.4630	46.0426	20.2988	18.7426	197.6132	48.5305	18.7706
36	22.2818	197.2455	47.5006	22.3289	20.9745	197.3888	49.6948	21.0137
37	24.3351	197.0027	48.9660	24.3965	23.2417	197.1347	50.8516	23.2952
38	26.4190	196.7341	50.4386	26.4976	25.5412	196.8499	52.0011	25.6122
39	28.5296	196.4391	51.9183	28.6287	27.8701	196.5337	53.1436	27.9625
40	30.6635	196.1173	53.4052	30.7867	30.2261	196.1852	54.2790	30.3442
41	32.8186	195.7682	54.8994	32.9700	32.6084	195.8033	55.4074	32.7569
42	32.9433	195.7473	54.9656	33.0965	32.6818	195.7911	55.4511	32.8313
43	32.9966	195.7383	55.0691	33.1505	32.7965	195.7719	55.4407	32.9476
44	33.0068	195.7366	55.1854	33.1609	32.8985	195.7548	55.3865	33.0510
45	32.9724	195.7424	55.2969	33.1259	32.9724	195.7424	55.2969	33.1259

X_{3D}, Y_{3D}, Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)
 X_{2D}, Z : Two-dimensional coordinate system (axial and circumferential coordinates)



付図 1.9 タービン静翼・動翼の配置（原寸）と設計点における速度三角形（測定位置 $N_R=8$ ，半径 $R=201\text{mm}$ ，スパン方向位置 $y/H=0.357$ ）

付表 1.25 タービン静翼・動翼の仕様（測定位置 $N_R=8$ ，半径 $R=201\text{mm}$ ）

		Nozzle	Rotor
Chord	C	67.10 mm	57.60 mm
Axial Chord	C_{ax}	42.03 mm	43.35 mm
Blade Pitch	S	45.33 mm	40.94 mm
Solidity	C/S	1.480	1.407
Inlet Blade Angle	α_1	0.00 deg	32.18 deg
Exit Blade Angle	α_2	68.44 deg	62.26 deg
Blade Turning Angle	$\alpha_2 - \alpha_1$	68.44 deg	94.43 deg
Stagger Angle	ξ	51.48 deg	41.60 deg
Trailing Edge Diameter	d_{TE}	0.6 mm	0.6 mm
Flow Coefficient	ϕ	0.526	
Blade Loading Coefficient	ψ	1.331	
Reaction	Λ	0.335	
Nozzle / Rotor Axial Spacing	L_{NR}	26.79 mm	

付表 1.26 タービン静翼の座標 (測定位置 $N_R=8$, 半径 $R=201\text{mm}$)
 ハブ側壁面からの距離 $y=26.0\text{mm}$, スパン方向位置 $y/H=0.357$

No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-0.0734	202.0000	4.5754	-0.0734	-0.0734	202.0000	4.5754	-0.0734
2	-0.5723	201.9992	4.6481	-0.5723	0.4253	201.9996	4.6526	0.4253
3	-0.9273	201.9979	4.7886	-0.9273	0.7776	201.9985	4.8118	0.7776
4	-1.2681	201.9960	4.9927	-1.2681	1.1093	201.9970	5.0572	1.1093
5	-1.6016	201.9937	5.2563	-1.6016	1.4211	201.9950	5.3930	1.4211
6	-1.9312	201.9908	5.5758	-1.9312	1.7086	201.9928	5.8228	1.7086
7	-2.2602	201.9874	5.9482	-2.2603	1.9647	201.9904	6.3495	1.9647
8	-2.5920	201.9834	6.3712	-2.5920	2.1806	201.9882	6.9755	2.1806
9	-2.9301	201.9787	6.8435	-2.9302	2.3457	201.9864	7.7022	2.3458
10	-3.2789	201.9734	7.3647	-3.2791	2.4485	201.9852	8.5298	2.4485
11	-3.6633	201.9668	7.9678	-3.6635	2.4746	201.9848	9.5089	2.4746
12	-4.2461	201.9554	8.9132	-4.2464	2.3386	201.9865	11.0618	2.3387
13	-4.8271	201.9423	9.8637	-4.8276	2.0136	201.9900	12.6102	2.0136
14	-5.4281	201.9271	10.8304	-5.4287	1.5212	201.9943	14.1428	1.5212
15	-6.0651	201.9089	11.8210	-6.0660	0.8775	201.9981	15.6520	0.8775
16	-6.7508	201.8872	12.8406	-6.7520	0.0952	202.0000	17.1325	0.0952
17	-7.4956	201.8609	13.8918	-7.4973	-0.8151	201.9984	18.5819	-0.8151
18	-8.3080	201.8291	14.9757	-8.3104	-1.8450	201.9916	19.9988	-1.8450
19	-9.1948	201.7906	16.0923	-9.1980	-2.9873	201.9779	21.3834	-2.9874
20	-10.1615	201.7443	17.2406	-10.1658	-4.2366	201.9556	22.7364	-4.2369
21	-11.2126	201.6886	18.4192	-11.2183	-5.5880	201.9227	24.0594	-5.5887
22	-12.3514	201.6220	19.6261	-12.3591	-7.0381	201.8774	25.3543	-7.0396
23	-13.5806	201.5430	20.8595	-13.5908	-8.5840	201.8175	26.6228	-8.5866
24	-14.9022	201.4496	22.1174	-14.9157	-10.2233	201.7411	27.8669	-10.2277
25	-16.3175	201.3399	23.3977	-16.3353	-11.9543	201.6460	29.0885	-11.9613
26	-17.8275	201.2118	24.6988	-17.8507	-13.7756	201.5297	30.2897	-13.7863
27	-19.4330	201.0631	26.0187	-19.4631	-15.6862	201.3900	31.4718	-15.7020
28	-21.1342	200.8914	27.3560	-21.1729	-17.6851	201.2243	32.6366	-17.7078
29	-22.9311	200.6942	28.7093	-22.9807	-19.7718	201.0300	33.7854	-19.8035
30	-24.8239	200.4689	30.0774	-24.8868	-21.9457	200.8043	34.9193	-21.9891
31	-26.8120	200.2127	31.4592	-26.8914	-24.2064	200.5444	36.0396	-24.2647
32	-28.8953	199.9226	32.8538	-28.9948	-26.5535	200.2471	37.1469	-26.6306
33	-31.0733	199.5957	34.2605	-31.1971	-28.9867	199.9094	38.2421	-29.0872
34	-33.3455	199.2287	35.6788	-33.4988	-31.5057	199.5279	39.3256	-31.6349
35	-35.7112	198.8183	37.1080	-35.8999	-34.1104	199.0992	40.3980	-34.2747
36	-38.1700	198.3609	38.5482	-38.4009	-36.8007	198.6195	41.4595	-37.0073
37	-40.7215	197.8529	39.9989	-41.0025	-39.5763	198.0851	42.5102	-39.8340
38	-43.3656	197.2902	41.4603	-43.7058	-42.4379	197.4918	43.5502	-42.7564
39	-46.1027	196.6686	42.9324	-46.5126	-45.3860	196.8352	44.5792	-45.7768
40	-48.9347	195.9831	44.4154	-49.4264	-48.4230	196.1102	45.5970	-48.8992
41	-51.8694	195.2270	45.9096	-52.4570	-51.5565	195.3098	46.6029	-52.1334
42	-51.9138	195.2152	46.0410	-52.5029	-51.7176	195.2672	46.5557	-52.3000
43	-51.9778	195.1981	46.1371	-52.5692	-51.8277	195.2380	46.5310	-52.4139
44	-52.0015	195.1918	46.2513	-52.5938	-51.9203	195.2134	46.4644	-52.5097
45	-51.9813	195.1972	46.3662	-52.5728	-51.9813	195.1972	46.3662	-52.5728

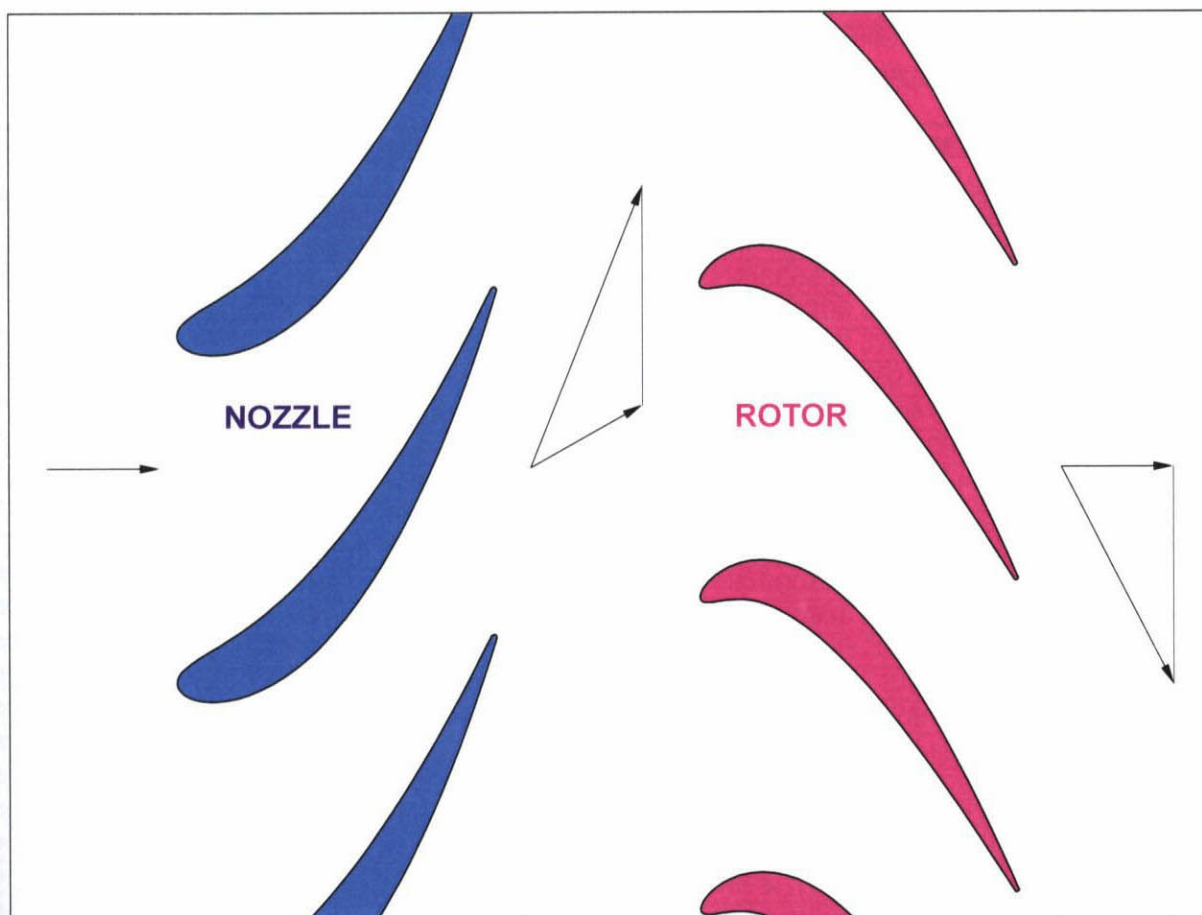
X_{3D} , Y_{3D} , Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)

X_{2D} , Z : Two-dimensional coordinate system (axial and circumferential coordinates)

付表 1.27 タービン動翼の座標 (測定位置 $N_R=8$, 半径 $R=201\text{mm}$)
 ハブ側壁面からの距離 $y=26.0\text{mm}$, スパン方向位置 $y/H=0.357$

No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-4.9908	201.9383	11.7652	-4.9913	-4.9908	201.9383	11.7652	-4.9913
2	-4.7687	201.9437	12.0351	-4.7692	-5.3401	201.9294	11.6493	-5.3407
3	-4.6882	201.9456	12.3216	-4.6886	-5.6709	201.9204	11.6710	-5.6716
4	-4.6698	201.9460	12.6719	-4.6702	-6.0537	201.9093	11.7829	-6.0546
5	-4.7030	201.9452	13.0851	-4.7034	-6.4862	201.8958	11.9863	-6.4873
6	-4.7773	201.9435	13.5585	-4.7777	-6.9619	201.8800	12.2838	-6.9632
7	-4.8809	201.9410	14.0884	-4.8814	-7.4714	201.8618	12.6791	-7.4731
8	-5.0007	201.9381	14.6708	-5.0012	-8.0032	201.8414	13.1765	-8.0052
9	-5.1223	201.9350	15.3008	-5.1228	-8.5433	201.8193	13.7809	-8.5458
10	-5.2306	201.9323	15.9728	-5.2312	-9.0755	201.7960	14.4982	-9.0785
11	-5.3135	201.9301	16.7189	-5.3141	-9.6059	201.7715	15.3820	-9.6096
12	-5.3454	201.9293	17.8177	-5.3460	-10.2478	201.7399	16.8575	-10.2522
13	-5.2648	201.9314	18.8371	-5.2654	-10.6536	201.7189	18.4132	-10.6585
14	-5.0868	201.9359	19.8002	-5.0873	-10.8217	201.7099	20.0257	-10.8269
15	-4.8239	201.9424	20.7357	-4.8243	-10.7535	201.7136	21.6660	-10.7586
16	-4.4807	201.9503	21.6737	-4.4810	-10.4580	201.7291	23.3041	-10.4627
17	-4.0531	201.9593	22.6391	-4.0534	-9.9528	201.7547	24.9150	-9.9568
18	-3.5324	201.9691	23.6480	-3.5326	-9.2598	201.7877	26.4824	-9.2631
19	-2.9092	201.9790	24.7072	-2.9093	-8.4014	201.8252	27.9997	-8.4038
20	-2.1768	201.9883	25.8168	-2.1768	-7.3971	201.8645	29.4666	-7.3988
21	-1.3318	201.9956	26.9733	-1.3318	-6.2628	201.9029	30.8870	-6.2638
22	-0.3741	201.9997	28.1712	-0.3741	-5.0109	201.9378	32.2661	-5.0114
23	0.6941	201.9988	29.4050	0.6941	-3.6514	201.9670	33.6092	-3.6516
24	1.8690	201.9914	30.6697	1.8690	-2.1923	201.9881	34.9218	-2.1924
25	3.1458	201.9755	31.9609	3.1459	-0.6407	201.9990	36.2080	-0.6407
26	4.5190	201.9494	33.2745	4.5194	0.9974	201.9975	37.4717	0.9974
27	5.9831	201.9114	34.6077	5.9840	2.7164	201.9817	38.7160	2.7164
28	7.5321	201.8595	35.9577	7.5339	4.5110	201.9496	39.9434	4.5114
29	9.1602	201.7922	37.3224	9.1634	6.3763	201.8993	41.1561	6.3774
30	10.8617	201.7078	38.7001	10.8669	8.3075	201.8291	42.3559	8.3099
31	12.6308	201.6047	40.0893	12.6391	10.3000	201.7372	43.5440	10.3044
32	14.4621	201.4816	41.4888	14.4745	12.3493	201.6222	44.7217	12.3570
33	16.3502	201.3372	42.8978	16.3681	14.4513	201.4824	45.8899	14.4637
34	18.2900	201.1703	44.3153	18.3151	16.6019	201.3166	47.0493	16.6206
35	20.2767	200.9797	45.7410	20.3109	18.7973	201.1235	48.2006	18.8245
36	22.3053	200.7647	47.1741	22.3509	21.0338	200.9019	49.3442	21.0720
37	24.3718	200.5244	48.6147	24.4313	23.3083	200.6508	50.4804	23.3603
38	26.4719	200.2579	50.0622	26.5483	25.6178	200.3690	51.6093	25.6869
39	28.6022	199.9648	51.5169	28.6987	27.9597	200.0556	52.7314	28.0498
40	30.7596	199.6443	52.9787	30.8798	30.3322	199.7097	53.8463	30.4473
41	32.9424	199.2958	54.4477	33.0902	32.7345	199.3300	54.9543	32.8795
42	33.0671	199.2751	54.5117	33.2166	32.8088	199.3178	54.9989	32.9548
43	33.1211	199.2661	54.6148	33.2713	32.9234	199.2989	54.9877	33.0709
44	33.1321	199.2643	54.7310	33.2824	33.0250	199.2821	54.9329	33.1740
45	33.0984	199.2699	54.8427	33.2483	33.0984	199.2699	54.8427	33.2483

X_{3D} , Y_{3D} , Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)
 X_{2D} , Z : Two-dimensional coordinate system (axial and circumferential coordinates)



付図 1.10 タービン静翼・動翼の配置（原寸）と設計点における速度三角形
 （測定位置 $N_R=9$, 半径 $R=204.5\text{mm}$, スパン方向位置 $y/H=0.393$ ）

付表 1.28 タービン静翼・動翼の仕様（測定位置 $N_R=9$, 半径 $R=204.5\text{mm}$ ）

		Nozzle	Rotor
Chord	C	67.24 mm	57.55 mm
Axial Chord	C_{ax}	42.26 mm	42.57 mm
Blade Pitch	S	46.11 mm	41.65 mm
Solidity	C/S	1.458	1.382
Inlet Blade Angle	α_1	0.00 deg	28.95 deg
Exit Blade Angle	α_2	68.10 deg	62.66 deg
Blade Turning Angle	$\alpha_2 - \alpha_1$	68.10 deg	91.61 deg
Stagger Angle	ξ	51.32 deg	42.67 deg
Trailing Edge Diameter	d_{TE}	0.6 mm	0.6 mm
Flow Coefficient	Φ	0.517	
Blade Loading Coefficient	ψ	1.286	
Reaction	Λ	0.357	
Nozzle / Rotor Axial Spacing	L_{NR}	27.12 mm	

付表 1.29 タービン静翼の座標 (測定位置 $N_R=9$, 半径 $R=204.5\text{mm}$)
 ハブ側壁面からの距離 $y=29.5\text{mm}$, スパン方向位置 $y/H=0.393$

No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-0.0829	205.5000	4.3389	-0.0829	-0.0829	205.5000	4.3389	-0.0829
2	-0.5829	205.4992	4.4120	-0.5829	0.4169	205.4996	4.4165	0.4169
3	-0.9386	205.4979	4.5533	-0.9386	0.7698	205.4986	4.5766	0.7698
4	-1.2802	205.4960	4.7585	-1.2802	1.1022	205.4970	4.8235	1.1022
5	-1.6144	205.4937	5.0235	-1.6144	1.4145	205.4951	5.1613	1.4146
6	-1.9449	205.4908	5.3447	-1.9450	1.7024	205.4929	5.5935	1.7024
7	-2.2749	205.4874	5.7191	-2.2750	1.9586	205.4907	6.1234	1.9586
8	-2.6078	205.4835	6.1444	-2.6078	2.1743	205.4885	6.7530	2.1744
9	-2.9472	205.4789	6.6192	-2.9473	2.3389	205.4867	7.4839	2.3390
10	-3.2976	205.4735	7.1433	-3.2977	2.4406	205.4855	8.3162	2.4407
11	-3.6840	205.4670	7.7498	-3.6842	2.4650	205.4852	9.3008	2.4650
12	-4.2705	205.4556	8.7009	-4.2708	2.3253	205.4868	10.8622	2.3254
13	-4.8557	205.4426	9.6575	-4.8561	1.9956	205.4903	12.4186	1.9957
14	-5.4615	205.4274	10.6306	-5.4621	1.4978	205.4945	13.9589	1.4978
15	-6.1040	205.4093	11.6279	-6.1049	0.8482	205.4982	15.4754	0.8482
16	-6.7958	205.3876	12.6545	-6.7970	0.0595	205.5000	16.9631	0.0595
17	-7.5473	205.3614	13.7129	-7.5490	-0.8575	205.4982	18.4193	-0.8575
18	-8.3667	205.3296	14.8042	-8.3690	-1.8943	205.4913	19.8428	-1.8943
19	-9.2609	205.2912	15.9283	-9.2641	-3.0437	205.4775	21.2340	-3.0439
20	-10.2353	205.2449	17.0843	-10.2395	-4.3001	205.4550	22.5936	-4.3004
21	-11.2941	205.1894	18.2704	-11.2998	-5.6587	205.4221	23.9230	-5.6594
22	-12.4406	205.1231	19.4850	-12.4482	-7.1158	205.3768	25.2243	-7.1172
23	-13.6774	205.0443	20.7261	-13.6875	-8.6684	205.3171	26.4993	-8.6710
24	-15.0062	204.9514	21.9915	-15.0196	-10.3142	205.2410	27.7499	-10.3185
25	-16.4284	204.8423	23.2795	-16.4459	-12.0514	205.1463	28.9781	-12.0583
26	-17.9447	204.7150	24.5880	-17.9675	-13.8782	205.0308	30.1858	-13.8888
27	-19.5556	204.5674	25.9154	-19.5853	-15.7938	204.8922	31.3745	-15.8094
28	-21.2615	204.3972	27.2602	-21.2996	-17.7970	204.7279	32.5459	-17.8193
29	-23.0621	204.2018	28.6209	-23.1108	-19.8871	204.5355	33.7014	-19.9183
30	-24.9573	203.9789	29.9964	-25.0191	-22.0634	204.3122	34.8420	-22.1060
31	-26.9466	203.7256	31.3856	-27.0244	-24.3253	204.0552	35.9690	-24.3824
32	-29.0296	203.4393	32.7875	-29.1270	-26.6722	203.7617	37.0830	-26.7477
33	-31.2054	203.1169	34.2015	-31.3266	-29.1038	203.4287	38.1850	-29.2020
34	-33.4736	202.7554	35.6271	-33.6234	-31.6195	203.0528	39.2754	-31.7456
35	-35.8331	202.3518	37.0636	-36.0172	-34.2189	202.6310	40.3546	-34.3791
36	-38.2834	201.9025	38.5109	-38.5083	-36.9017	202.1596	41.4230	-37.1030
37	-40.8236	201.4043	39.9689	-41.0970	-39.6676	201.6352	42.4806	-39.9181
38	-43.4534	200.8533	41.4375	-43.7839	-42.5165	201.0537	43.5275	-42.8258
39	-46.1725	200.2457	42.9167	-46.5701	-45.4489	200.4112	44.5634	-45.8278
40	-48.9824	199.5770	44.4068	-49.4585	-48.4662	199.7030	45.5883	-48.9272
41	-51.8893	198.8410	45.9080	-52.4571	-51.5751	198.9228	46.6013	-52.1324
42	-51.9344	198.8293	46.0407	-52.5037	-51.7351	198.8812	46.5541	-52.2978
43	-51.9979	198.8126	46.1371	-52.5694	-51.8455	198.8524	46.5301	-52.4119
44	-52.0210	198.8066	46.2514	-52.5933	-51.9385	198.8282	46.4641	-52.5080
45	-52.0002	198.8121	46.3662	-52.5717	-52.0002	198.8121	46.3662	-52.5717

X_{3D}, Y_{3D}, Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)
 X_{2D}, Z : Two-dimensional coordinate system (axial and circumferential coordinates)

付表 1.30 タービン動翼の座標 (測定位置 $N_R=9$, 半径 $R=204.5\text{mm}$)
 ハブ側壁面からの距離 $y=29.5\text{mm}$, スパン方向位置 $y/H=0.393$

No.	Pressure surface coordinates				Suction surface coordinates			
	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm	X_{3D} mm	Y_{3D} mm	Z mm	X_{2D} mm
1	-5.6363	205.4227	12.0711	-5.6370	-5.6363	205.4227	12.0711	-5.6370
2	-5.4078	205.4288	12.3188	-5.4084	-5.9800	205.4130	11.9747	-5.9808
3	-5.3151	205.4313	12.5877	-5.3157	-6.2987	205.4034	12.0085	-6.2996
4	-5.2795	205.4322	12.9199	-5.2801	-6.6631	205.3919	12.1303	-6.6643
5	-5.2906	205.4319	13.3144	-5.2912	-7.0712	205.3783	12.3415	-7.0726
6	-5.3387	205.4306	13.7684	-5.3393	-7.5166	205.3625	12.6446	-7.5182
7	-5.4127	205.4287	14.2786	-5.4133	-7.9903	205.3446	13.0433	-7.9923
8	-5.5002	205.4264	14.8411	-5.5009	-8.4812	205.3249	13.5414	-8.4836
9	-5.5878	205.4240	15.4515	-5.5885	-8.9759	205.3039	14.1436	-8.9788
10	-5.6609	205.4220	16.1046	-5.6617	-9.4588	205.2822	14.8552	-9.4621
11	-5.7066	205.4207	16.8321	-5.7074	-9.9341	205.2597	15.7287	-9.9380
12	-5.6872	205.4213	17.9086	-5.6880	-10.4953	205.2318	17.1810	-10.4999
13	-5.5624	205.4247	18.9130	-5.5631	-10.8293	205.2145	18.7063	-10.8343
14	-5.3451	205.4305	19.8667	-5.3457	-10.9355	205.2088	20.2827	-10.9407
15	-5.0463	205.4380	20.7963	-5.0468	-10.8158	205.2152	21.8835	-10.8208
16	-4.6696	205.4469	21.7296	-4.6700	-10.4791	205.2326	23.4807	-10.4836
17	-4.2110	205.4569	22.6898	-4.2113	-9.9419	205.2594	25.0514	-9.9458
18	-3.6619	205.4674	23.6916	-3.6621	-9.2249	205.2928	26.5805	-9.2280
19	-3.0135	205.4779	24.7412	-3.0136	-8.3490	205.3303	28.0618	-8.3513
20	-2.2594	205.4876	25.8388	-2.2594	-7.3324	205.3691	29.4953	-7.3339
21	-1.3962	205.4953	26.9809	-1.3963	-6.1899	205.4068	30.8846	-6.1909
22	-0.4239	205.4996	28.1624	-0.4239	-4.9332	205.4408	32.2346	-4.9337
23	0.6559	205.4990	29.3782	0.6559	-3.5716	205.4690	33.5504	-3.5718
24	1.8396	205.4918	30.6235	1.8396	-2.1126	205.4891	34.8368	-2.1126
25	3.1228	205.4763	31.8941	3.1229	-0.5627	205.4992	36.0981	-0.5627
26	4.5006	205.4507	33.1863	4.5010	1.0725	205.4972	37.3378	1.0725
27	5.9678	205.4133	34.4973	5.9686	2.7877	205.4811	38.5588	2.7877
28	7.5190	205.3624	35.8246	7.5206	4.5781	205.4490	39.7635	4.5784
29	9.1487	205.2963	37.1661	9.1518	6.4390	205.3991	40.9539	6.4401
30	10.8519	205.2133	38.5202	10.8569	8.3662	205.3296	42.1318	8.3685
31	12.6231	205.1119	39.8855	12.6310	10.3553	205.2389	43.2983	10.3596
32	14.4573	204.9908	41.2609	14.4692	12.4021	205.1254	44.4547	12.4097
33	16.3496	204.8486	42.6454	16.3669	14.5030	204.9876	45.6018	14.5151
34	18.2953	204.6840	44.0384	18.3195	16.6541	204.8240	46.7403	16.6724
35	20.2898	204.4959	45.4394	20.3229	18.8519	204.6335	47.8708	18.8784
36	22.3289	204.2833	46.8477	22.3730	21.0931	204.4146	48.9937	21.1303
37	24.4085	204.0453	48.2634	24.4662	23.3748	204.1663	50.1092	23.4255
38	26.5249	203.7810	49.6860	26.5991	25.6943	203.8874	51.2177	25.7617
39	28.6749	203.4896	51.1156	28.7687	28.0493	203.5767	52.3192	28.1372
40	30.8558	203.1703	52.5522	30.9729	30.4382	203.2333	53.4138	30.5506
41	33.0661	202.8223	53.9962	33.2105	32.8606	202.8557	54.5014	33.0023
42	33.1908	202.8019	54.0579	33.3368	32.9357	202.8435	54.5468	33.0783
43	33.2455	202.7930	54.1606	33.3922	33.0502	202.8249	54.5348	33.1944
44	33.2572	202.7910	54.2768	33.4042	33.1515	202.8083	54.4793	33.2970
45	33.2243	202.7964	54.3887	33.3707	33.2243	202.7964	54.3887	33.3707

X_{3D}, Y_{3D}, Z : Three-dimensional coordinate system (Cartesian rectangular coordinates)
 X_{2D}, Z : Two-dimensional coordinate system (axial and circumferential coordinates)