Università degli Studi di Padova – Dipartimento di Ingegneria Industriale

Corso di Laurea in Ingegneria Meccanica

Relazione per la prova finale «Modellazione parametrica di eliche marine di superfice»

Tutor universitario: Prof. Giovanna Cavazzini

Laureando*: Massimiliano Spinazzè*

Padova, 14/03/2023

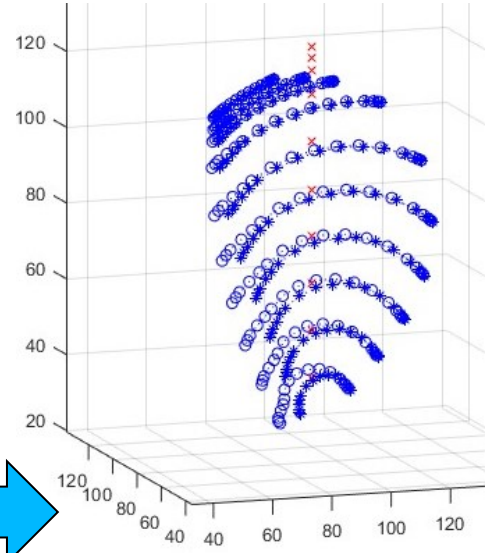
OBIETTIVI E METODOLOGIA DEL LAVORO

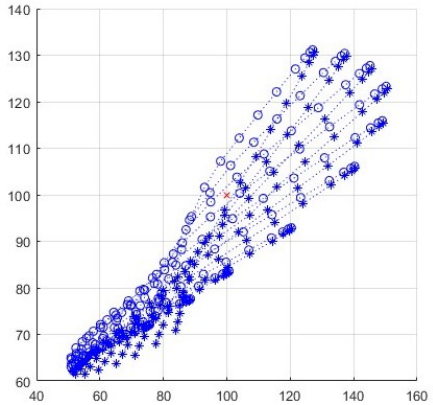
DATI DI PARTENZA

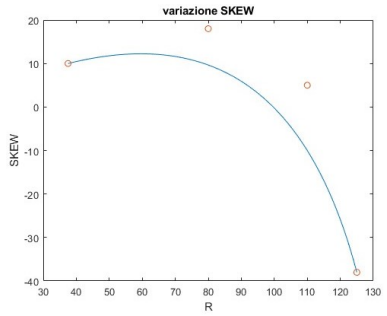
Elica 841_B

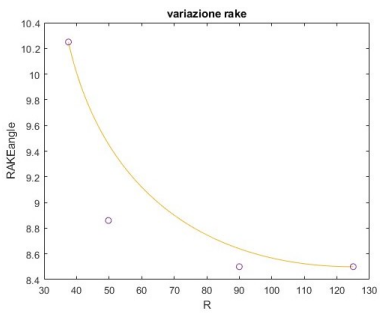
PARAMETRI GEOMETRICI FONDAMENTALI DELLE ELICHE

MODELLO MATLAB

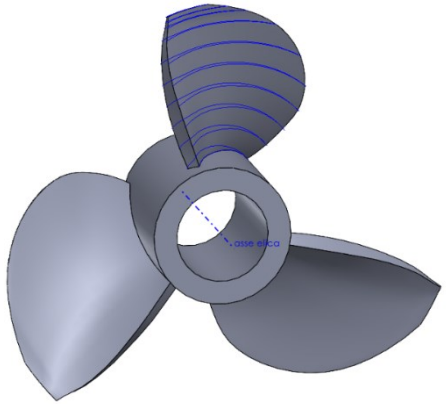


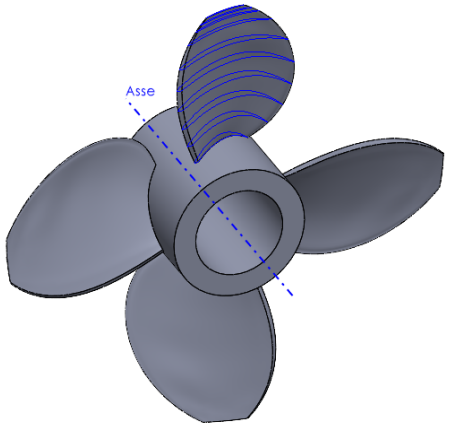






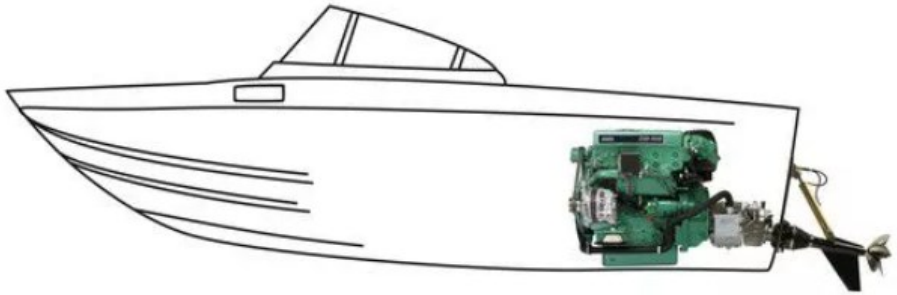
MODELLO CAD





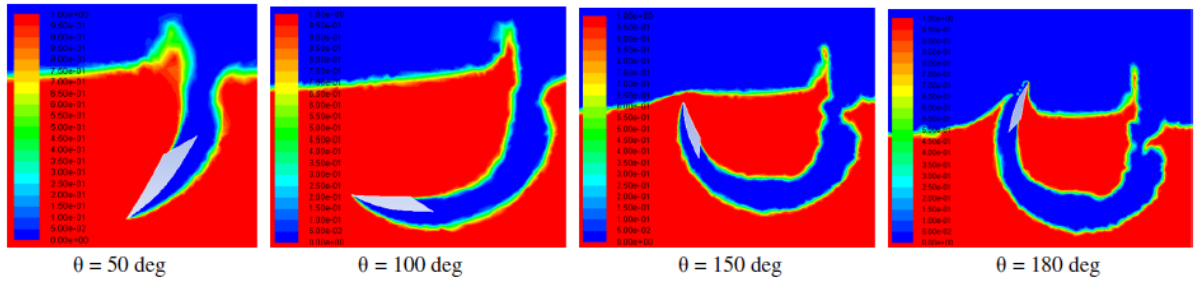
RIDUZIONE RESISTENZA ALL'AVANZAMENTO:

L'INEA D'ASSI ELICA DI SUPERFICIE

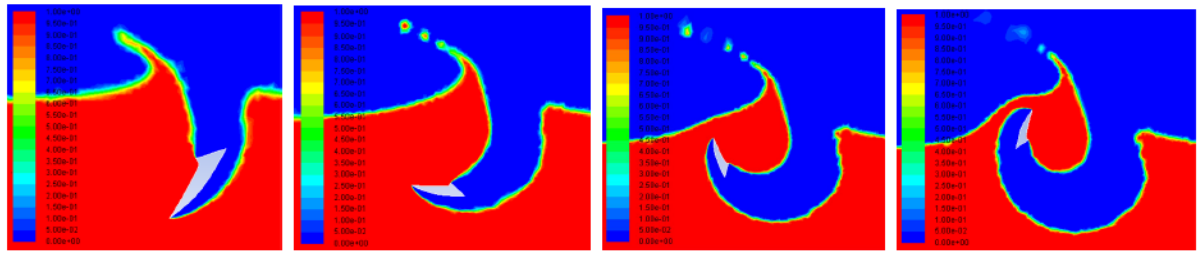


L'INEE D'ASSI ELICA NORMALE

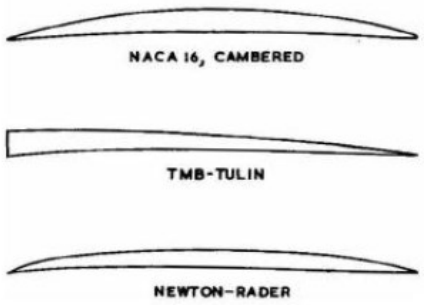
FORTE RIDUZIONE DEL FENOMENO DELLA CAVITAZIONE:

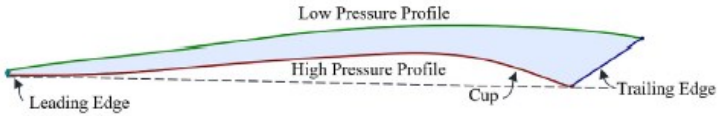


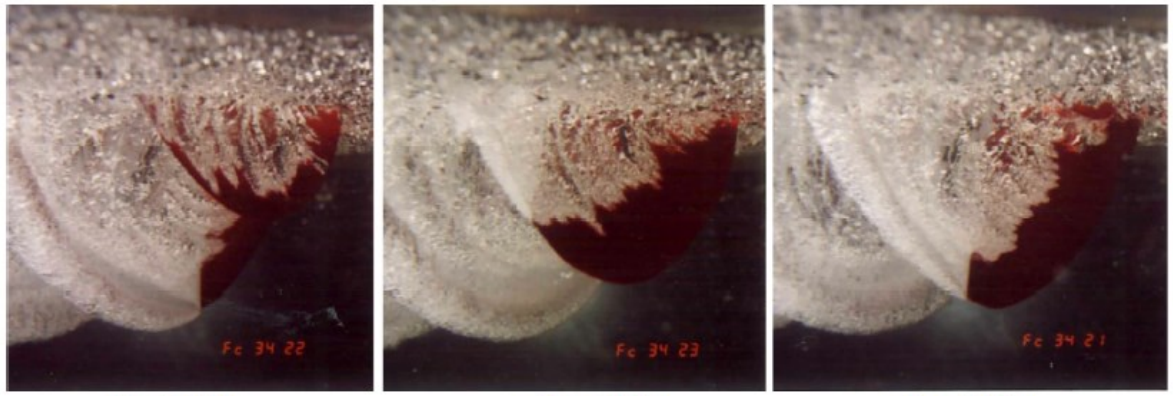
θ = 50 deg θ = 100 deg θ = 150 deg θ = 180 deg



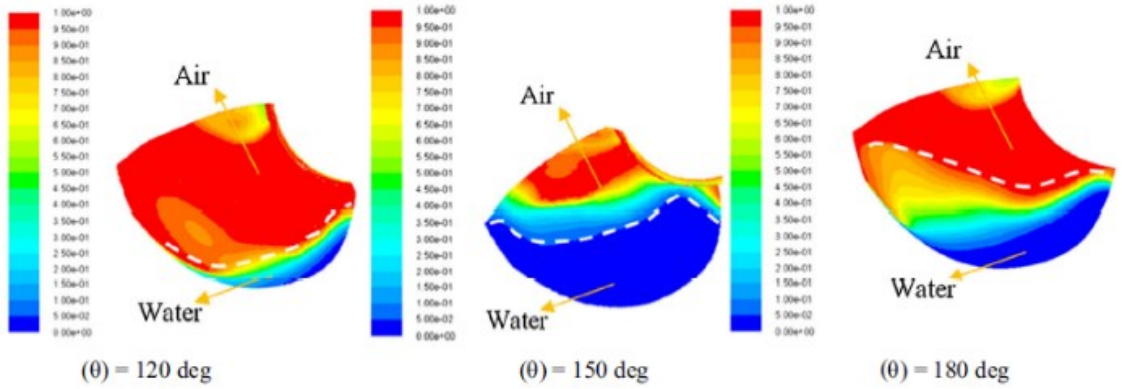
θ = 50 deg θ = 100 deg θ = 150 deg θ = 180 deg





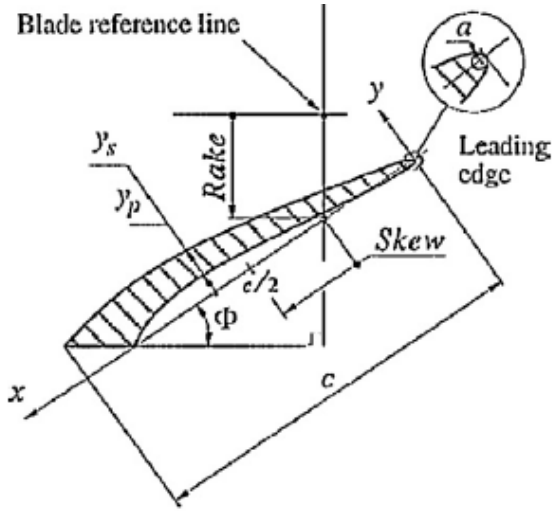


(θ) = 120 deg (θ) = 150 deg (θ) = 180 deg



(θ) = 120 deg (θ) = 150 deg (θ) = 180 deg

ELICA 841-B:

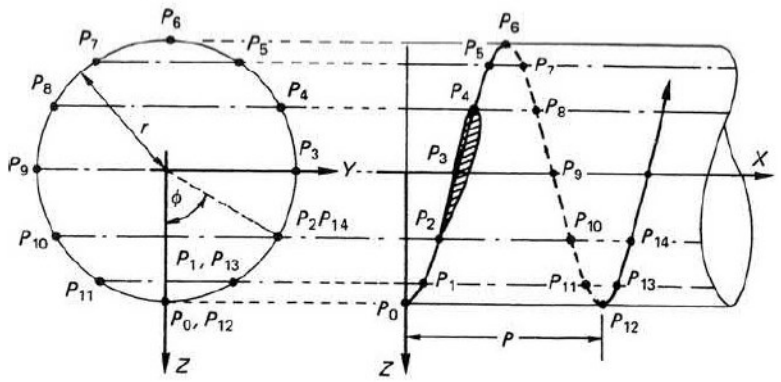


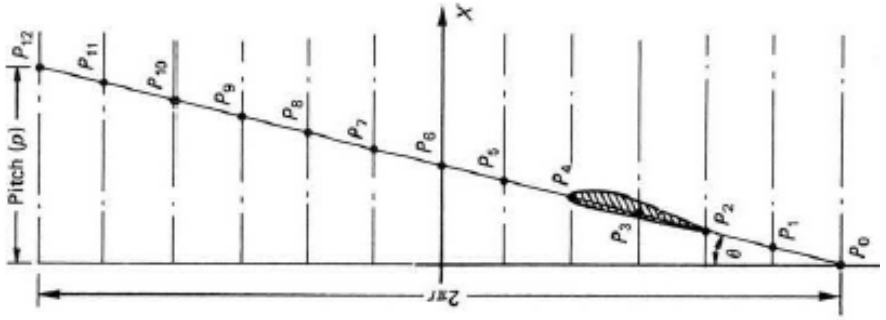
Parameter	Value
Diameter	250 (mm)
Hub diameter	85 (mm)
Pitch at 0.7 radius	310 (mm)
Pitch-diameter at 0.7 radius	1.24 (–)
Expanded area ratio	0.58 (–)
Number of blade	4 (–)

19	Radius [mm]	Chord [mm]	Skew [mm]	Rake [mm]	*a* [mm]	*Φ* [deg]
0.3	37.5	75.1	−9.94	6.75	0.117	52.8
0.4	50.0	87.2	−11.19	8.45	0.113	44.6
0.5	62.5	98.0	−11.13	10.12	0.095	38.3
0.6	75.0	105.0	−10.08	11.82	0.060	33.3
0.7	87.5	105.5	−5.71	13.52	0.034	29.4
0.8	100.0	97.3	1.85	15.20	0.021	26.3
0.9	112.5	75.8	14.38	16.90	0.012	23.7
0.95	118.8	53.7	25.24	17.27	0.008	22.6
0.975	121.9	40.5	31.95	18.15	0.007	22.0
1.0	125.0	26.7	39.05	18.58	0.005	21.5

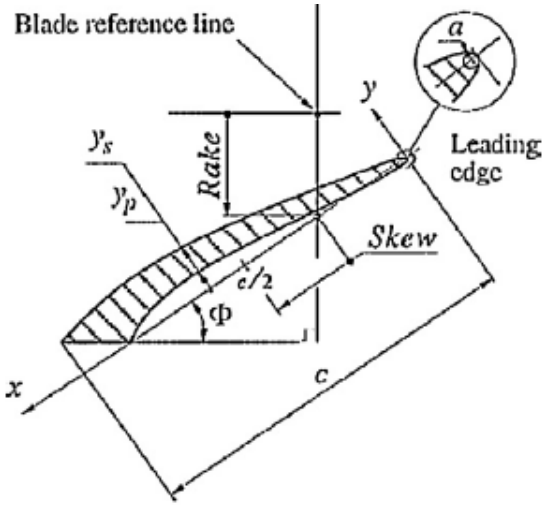
r/*R*	*r*/*c* *y*	.0125 [mm]	0.025 [mm]	0.05 [mm]	0.1 [mm]	0.2 [mm]	0.3 [mm]	0.4 [mm]	0.5 [mm]	0.6 [mm]	0.7 [mm]	0.8 [mm]	0.85 [mm]	0.9 [mm]	0.95 [mm]	0.975 [mm]	1.0 [mm]
0.3	*p*	−0.24	−0.23	−0.18	−0.04	0.30	0.70	1.13	1.56	1.98	2.41	2.32	1.73	0.84	−0.29	−0.89	−1.48
	s	0.62	0.95	1.50	2.48	4.23	5.90	7.59	9.28	9.90	9.40	7.60	7.00	7.00	7.00	6.60	5.59
0.4	*p*	−0.26	−0.25	−0.20	−0.04	0.34	0.79	1.26	1.73	2.20	2.67	2.39	1.64	0.57	−0.72	−1.38	−2.03
	s	0.57	0.88	1.40	2.31	3.94	5.50	7.08	8.66	9.05	9.40	7.80	7.30	7.50	7.50	7.20	6.70
0.5	*p*	−0.27	−0.27	−0.21	−0.05	0.36	0.85	1.35	1.86	2.36	2.85	2.40	1.52	0.31	−1.08	−1.78	−2.48
	s	0.51	0.78	1.24	2.05	3.50	4.90	6.31	7.71	8.65	8.80	7.50	7.20	7.50	7.65	7.40	7.00
0.6	*p*	−0.28	−0.27	−0.21	−0.04	0.38	0.87	1.38	1.90	2.41	2.91	2.36	1.43	0.16	−1.27	−1.98	−2.70
	s	0.43	0.66	1.05	1.74	2.97	4.15	5.35	6.55	7.40	7.60	6.40	6.00	6.50	7.00	6.80	6.60
0.7	*p*	−0.26	−0.26	−0.20	−0.04	0.35	0.82	1.31	1.79	2.28	2.75	2.27	1.40	0.22	−1.13	−1.80	−2.48
	s	0.34	0.53	0.83	1.38	2.35	3.29	4.23	5.18	6.00	6.30	5.40	4.80	5.20	5.80	5.65	5.40
0.8	*p*	−0.23	−0.22	−0.17	−0.03	0.30	0.71	1.13	1.55	1.97	2.39	2.05	1.34	0.34	−0.82	−1.41	−2.00
	s	0.26	0.40	0.62	1.04	1.77	2.47	3.18	3.88	4.70	5.10	4.70	4.20	4.40	4.70	4.50	4.20
0.9	*p*	−0.17	−0.17	−0.13	−0.03	0.22	0.51	0.82	1.13	1.44	1.74	1.58	1.10	0.41	−0.43	−0.86	−1.29
	s	0.17	0.27	0.42	0.70	1.19	1.66	2.14	2.61	3.10	3.30	2.95	2.60	2.70	2.90	2.70	2.50
0.95	*p*	−0.12	−0.11	−0.09	−0.02	0.15	0.35	0.56	0.77	0.98	1.20	1.10	0.79	0.32	−0.25	−0.54	−0.84
	s	0.12	0.18	0.29	0.48	0.81	1.13	1.46	1.78	2.05	2.20	2.05	1.80	1.95	1.95	1.80	1.70
0.975	*p*	−0.09	−0.08	−0.07	−0.02	0.11	0.26	0.42	0.57	0.73	0.89	0.83	0.60	0.26	−0.16	−0.38	−0.60
	s	0.09	0.14	0.22	0.36	0.61	0.85	1.09	1.33	1.55	1.60	1.50	1.40	1.45	1.35	1.30	1.20
1.0	*p*	−0.06	−0.06	−0.04	−0.01	0.07	0.17	0.27	0.37	0.47	0.57	0.56	0.41	0.19	−0.08	−0.22	−0.36
	s	0.06	0.09	0.14	0.23	0.40	0.56	0.72	0.88	1.05	1.20	1.15	1.10	1.00	0.90	0.80	0.75

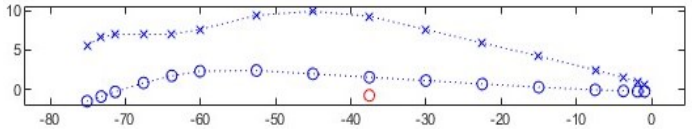
SEZIONI PALARI E PASSO:



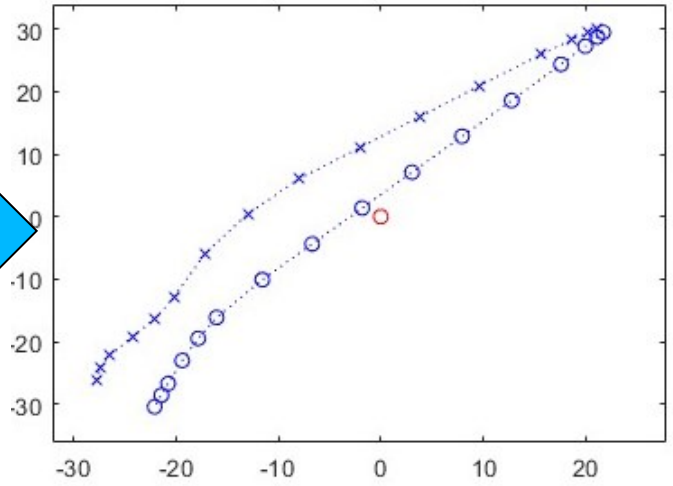


$$\theta = \tan^{-1}\left(\frac{p}{2\pi r}\right)$$



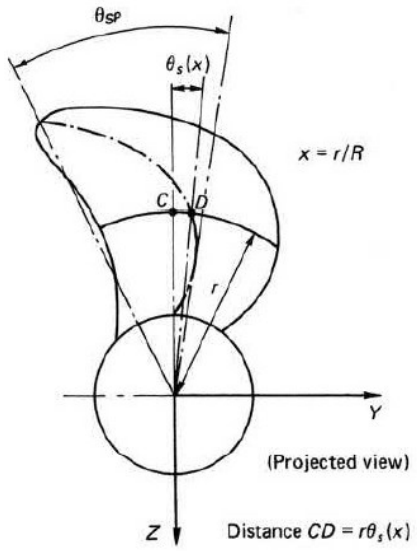


$$\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$$

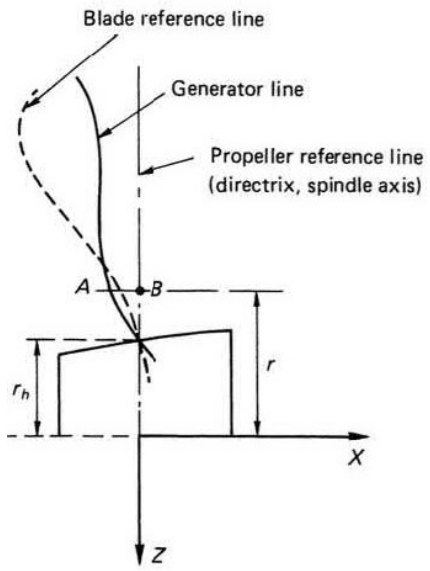


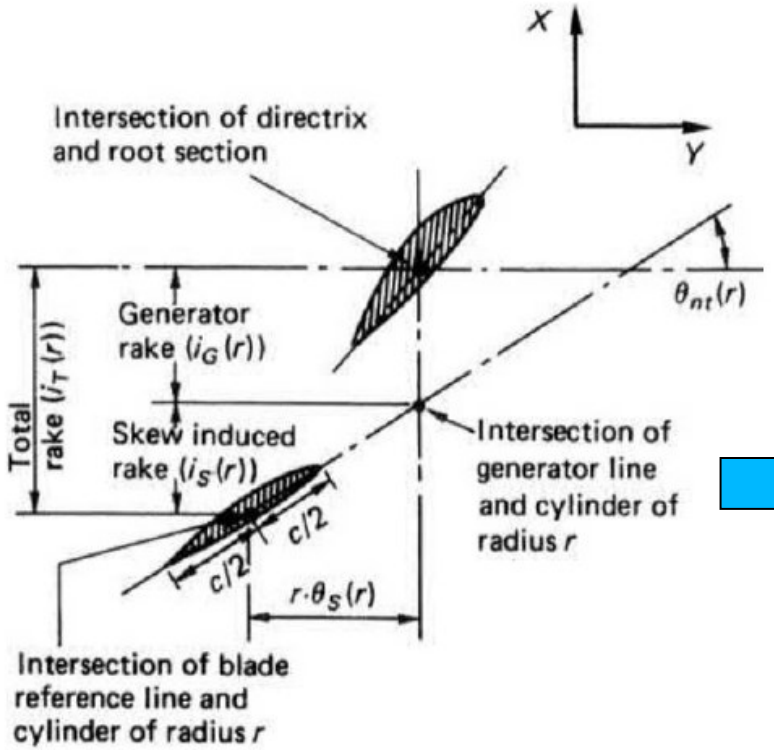
CREAZIONE DEL MODELLO MATLAB

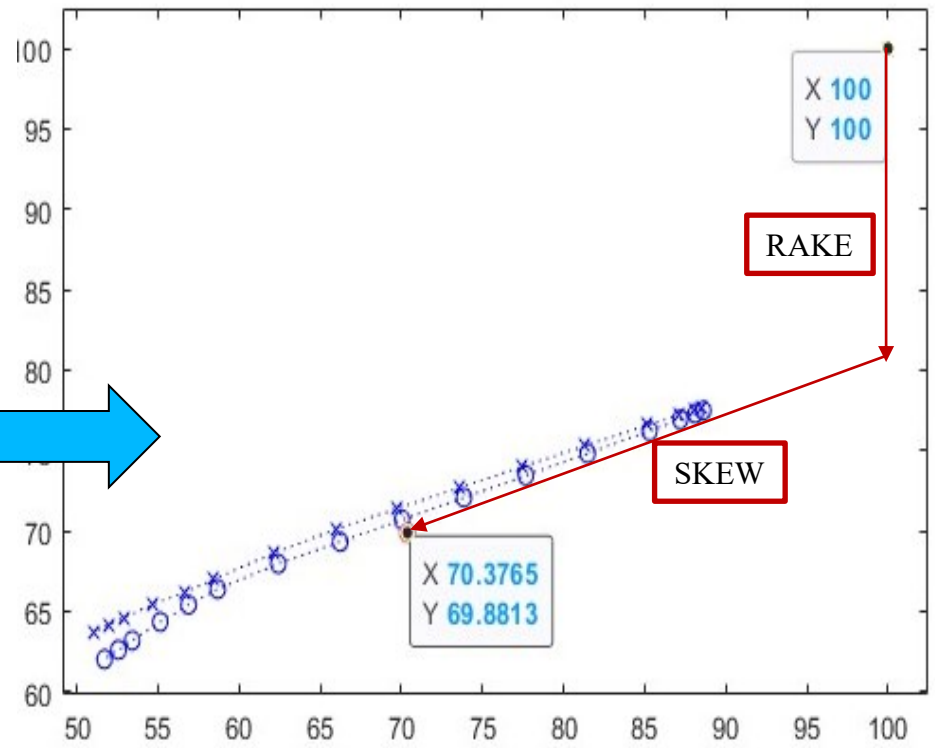
SKEW:



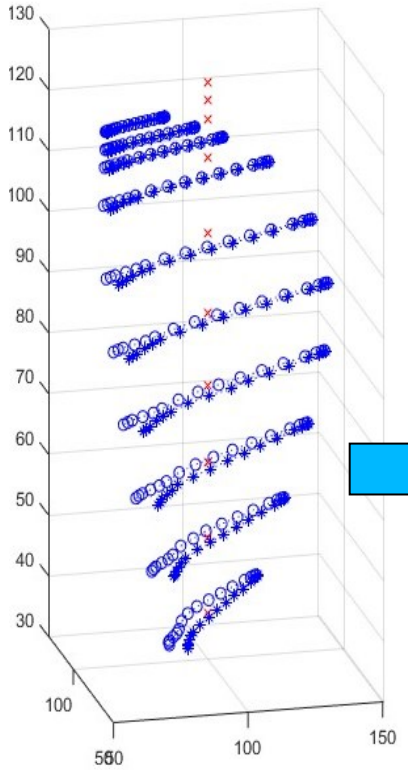
RAKE:

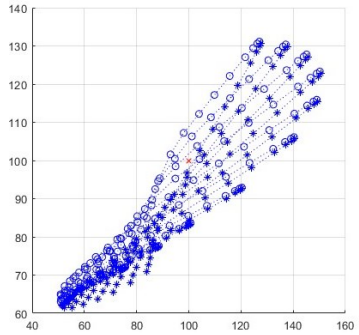






SEZIONI CILINDRICHE:





TEOREMA DEL COSENO:

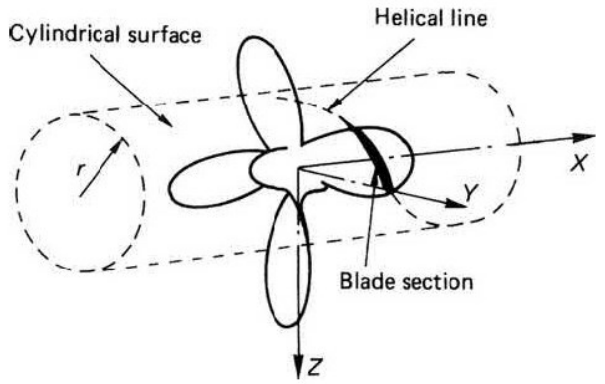
$$r^2 = r^2 + X^2 - 2rXcos(\alpha)$$

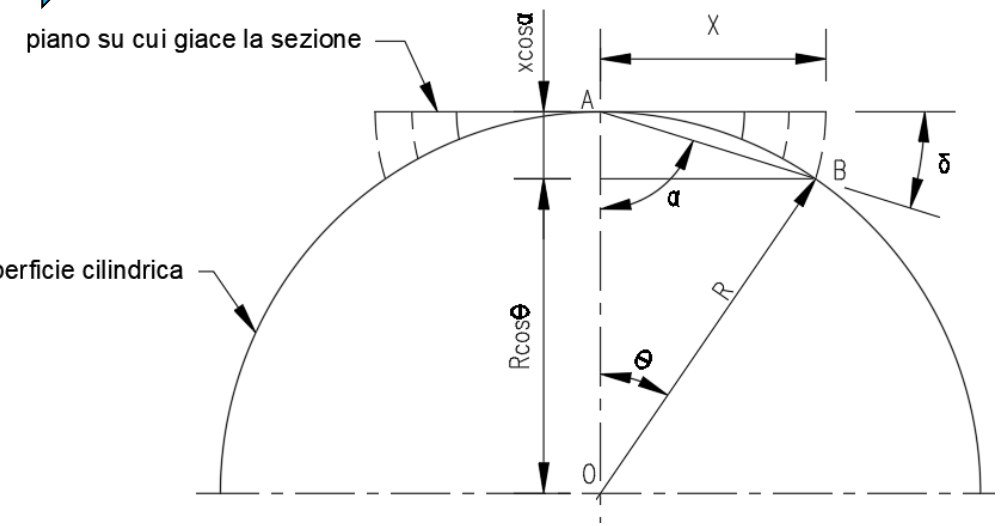
$$\alpha = arccos\left(\frac{X}{2r}\right)$$

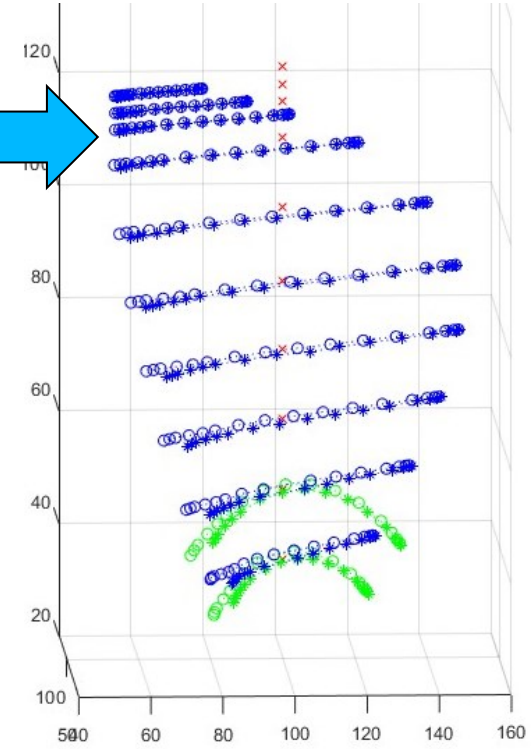
$$\delta = \frac{\pi}{2} - \alpha$$

ROTAZIONE NEL PIANO ZY:

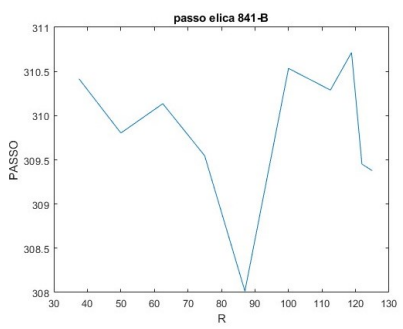
$$\begin{bmatrix} cos\delta & 0 & -sen\delta \\ 0 & 1 & 0 \\ sen\delta & 0 & cos\delta \end{bmatrix}$$

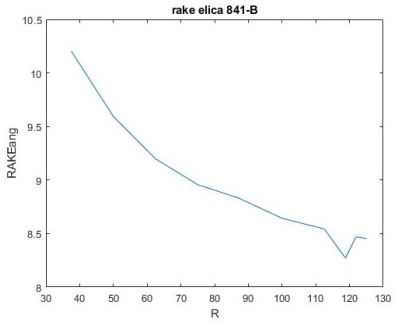


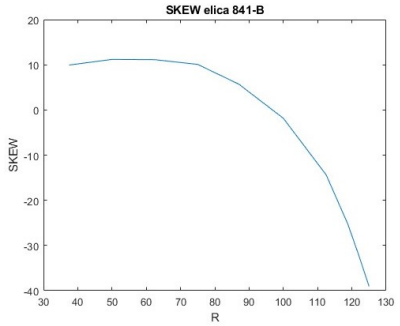


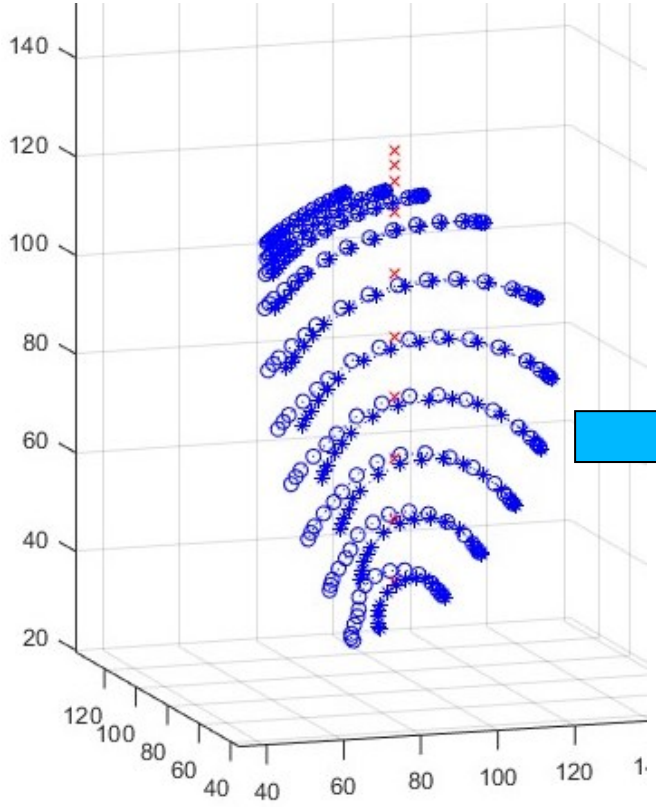


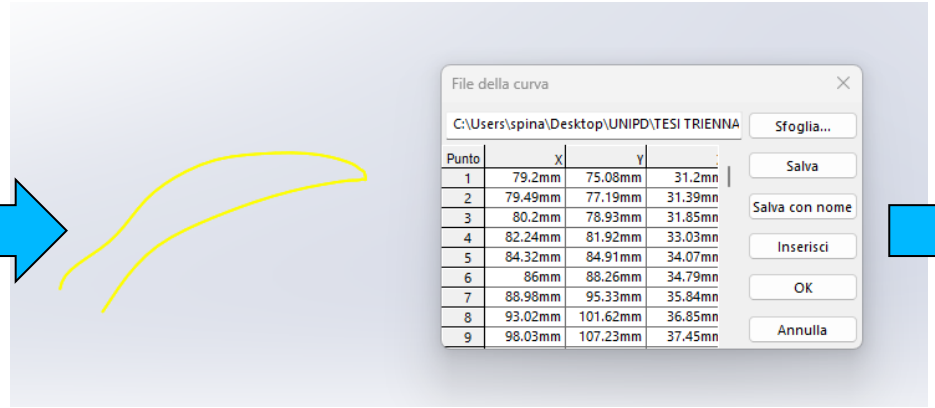
RISULTATO FINALE ELICA 841-B

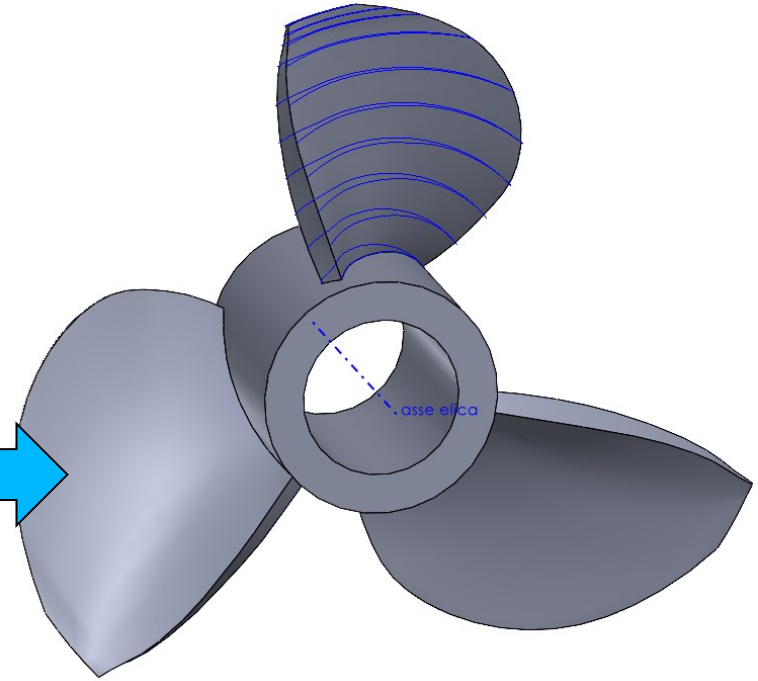












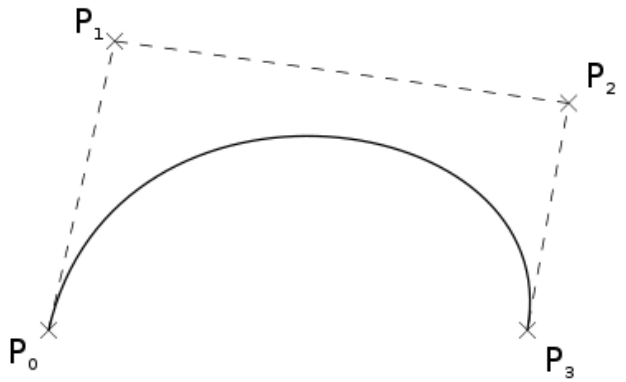
PARAMETRIZZAZIONE CON CURVE DI BEZIER

Curve definite dai polinomi di Bernstein:

$$\mathbf{B}(t) = \sum_{i=0}^{n} \binom{n}{i} P_i (1-t)^{n-i} t^i = P_0(1-t)^n + \binom{n}{1} P_1 (1-t)^{n-1} t + \cdots + P_n t^n, \quad t \in [0,1].$$

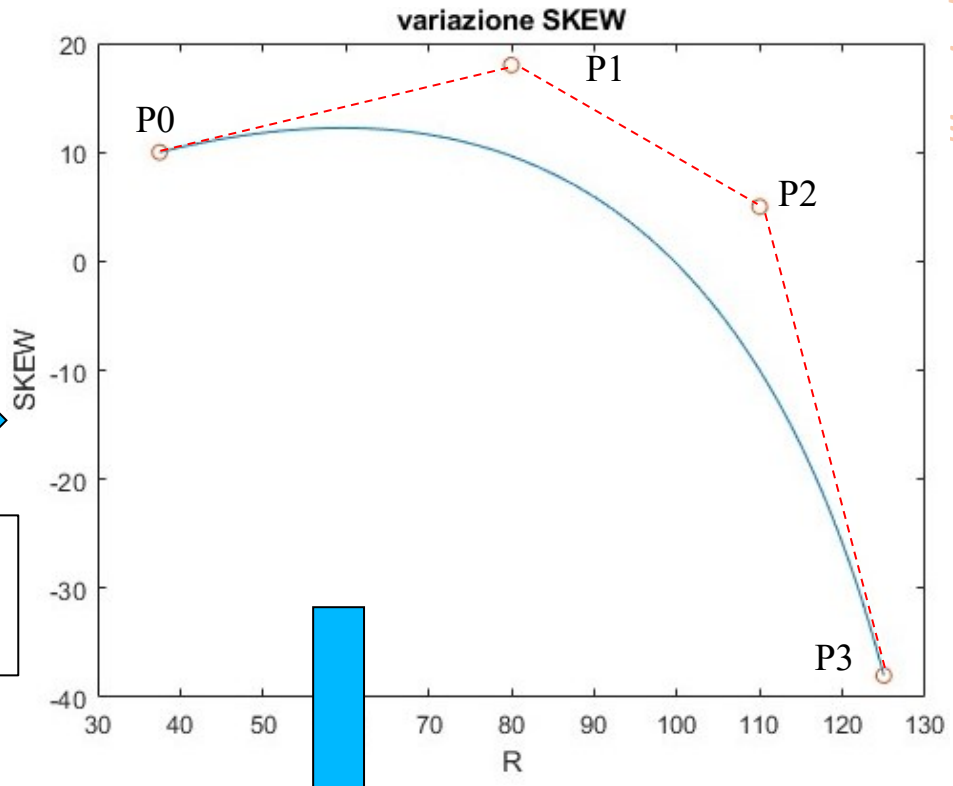
Curva di Bezier cubica:

$$\mathbf{B}(t) = P_0(1-t)^3 + 3P_1 t(1-t)^2 + 3P_2 t^2(1-t) + P_3 t^3, \quad t \in [0,1].$$



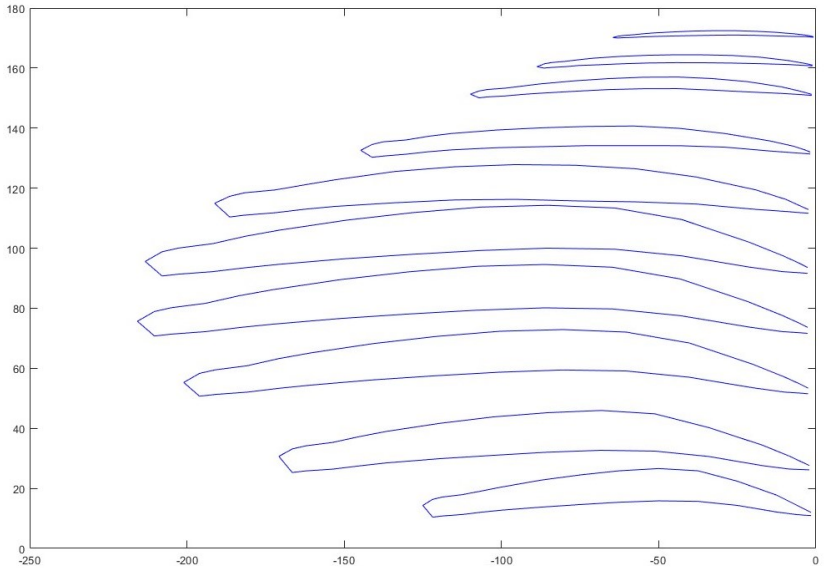
MATLAB FUNCTION

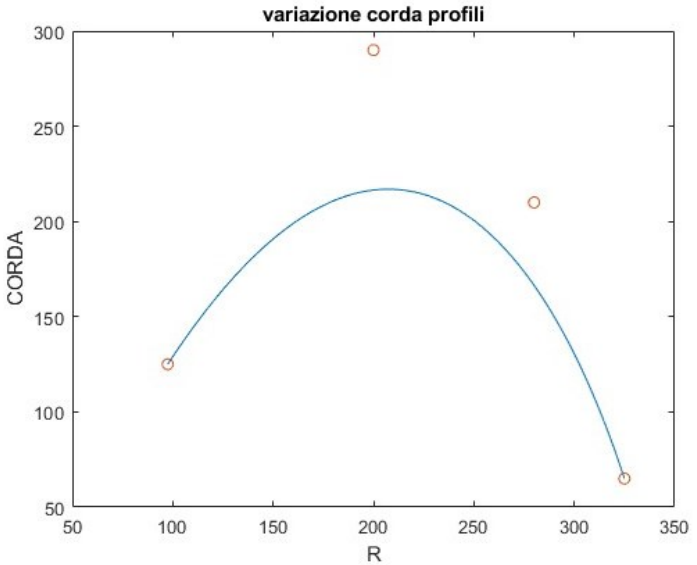
IMPUT:
- P0 , P3 PARAMETRI START/FINISH
- P1 , P2 PUNTI DI CONTROLLO
- POSIZIONI RADIALI DELLE SEZIONI

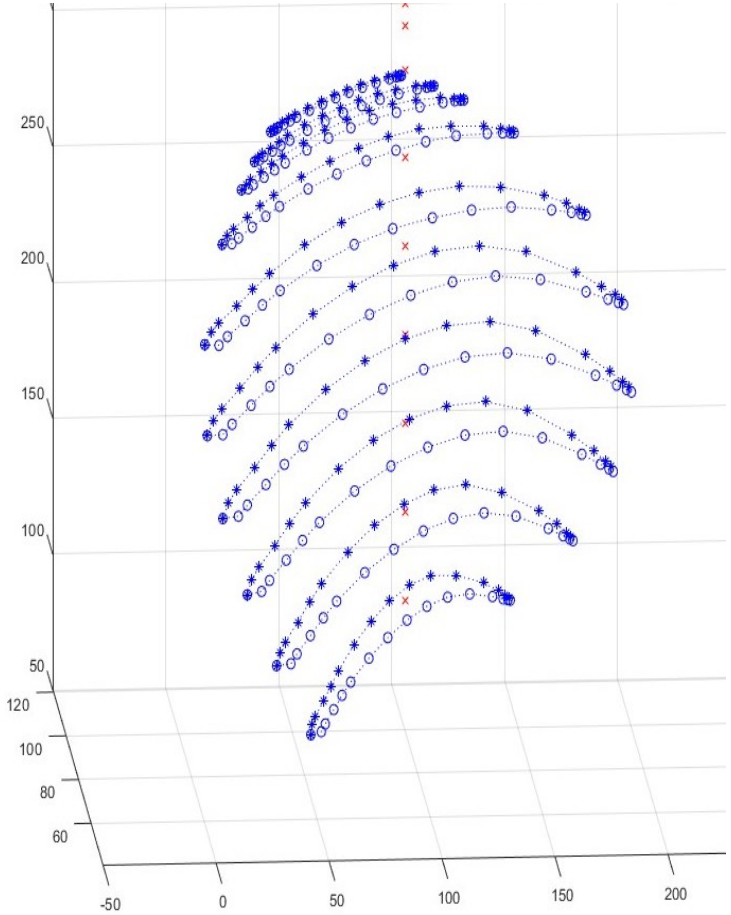


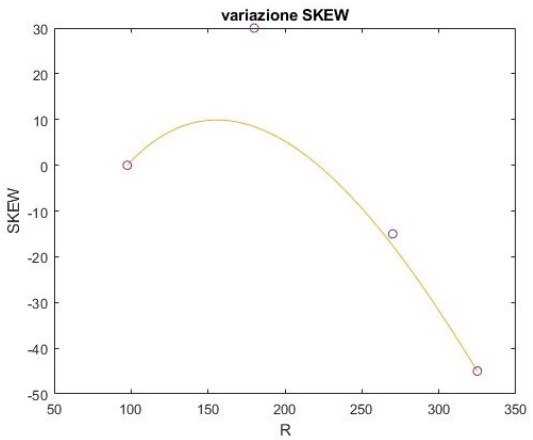
OUTPOT:
- VETTORE DI VALORI (1xn)
  n= sezioni palari

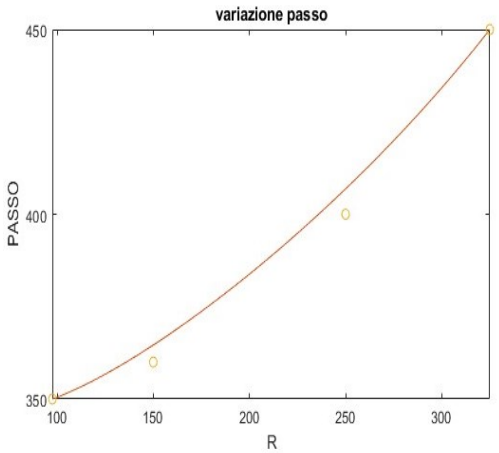
MODELLI ESEMPLIFICATIVI/ESEMPIO 1

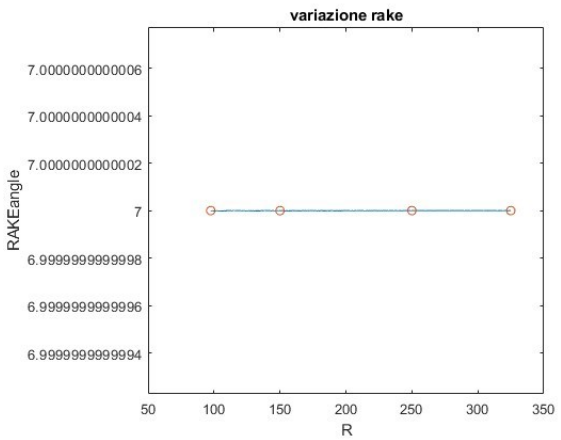




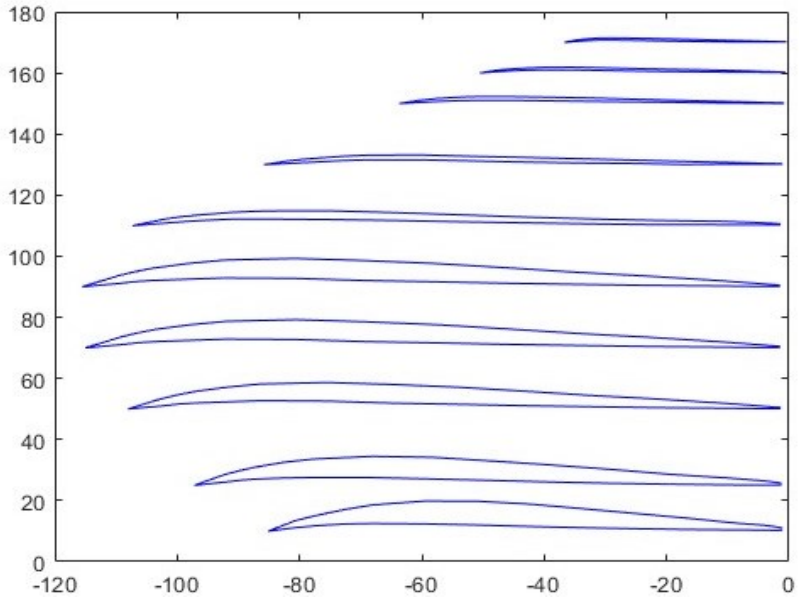


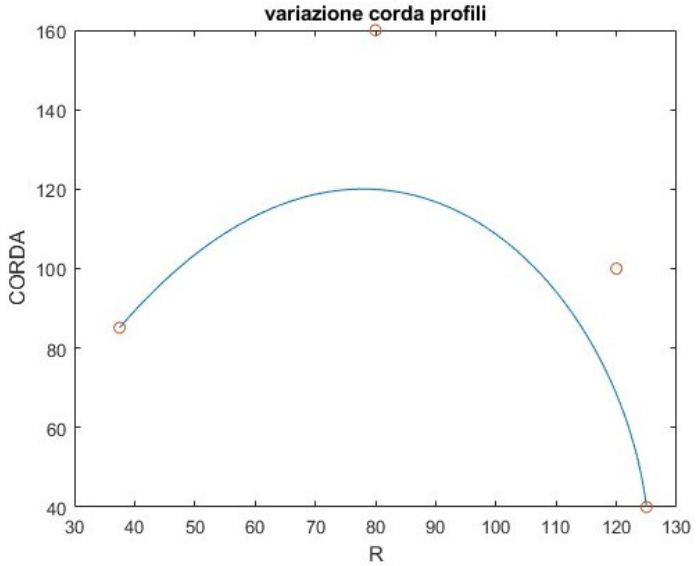


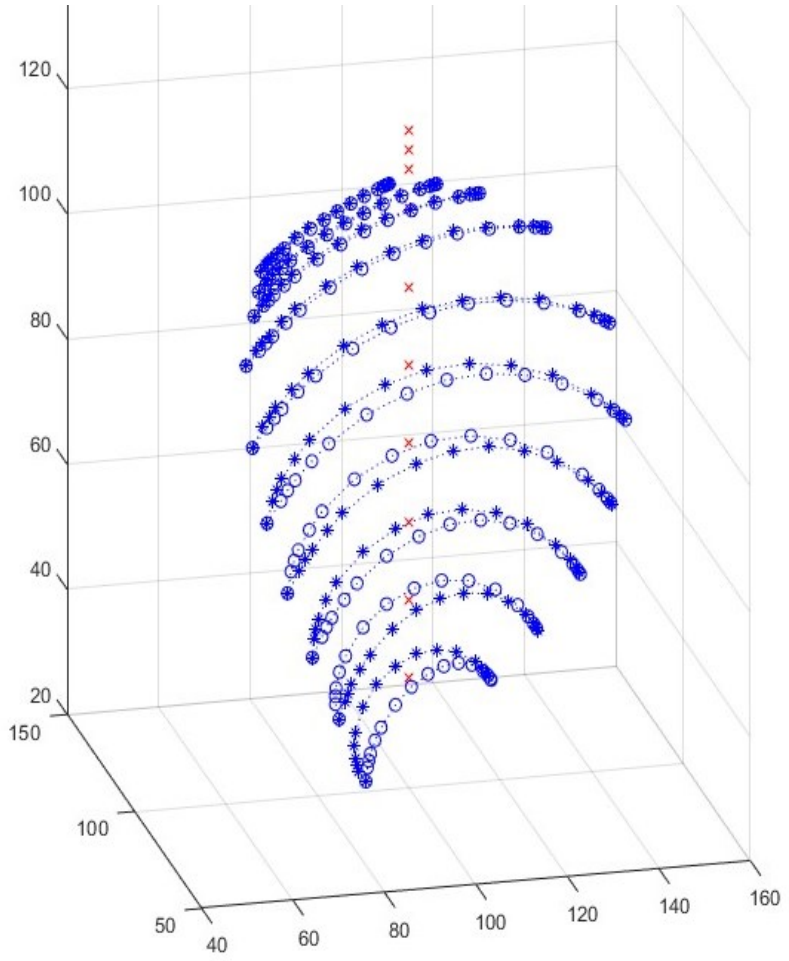


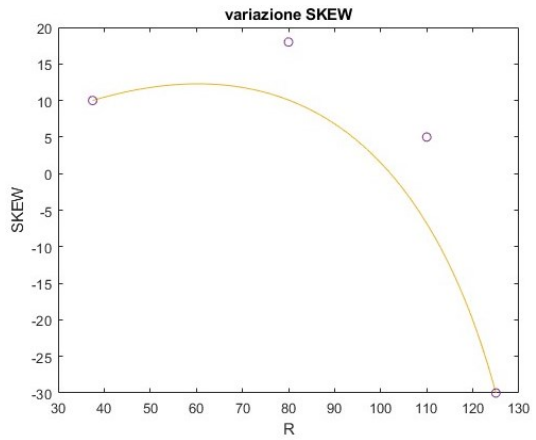


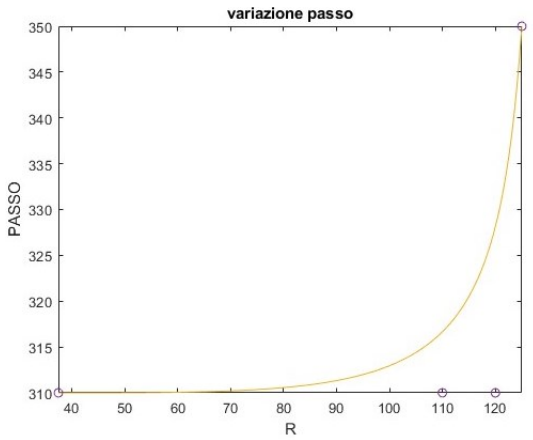
MODELLI ESEMPLIFICATIVI/ESEMPIO 2

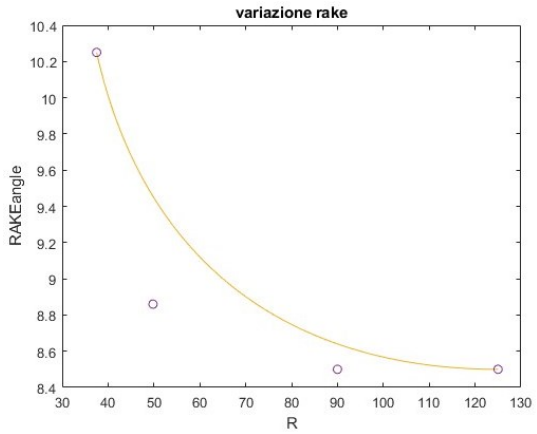






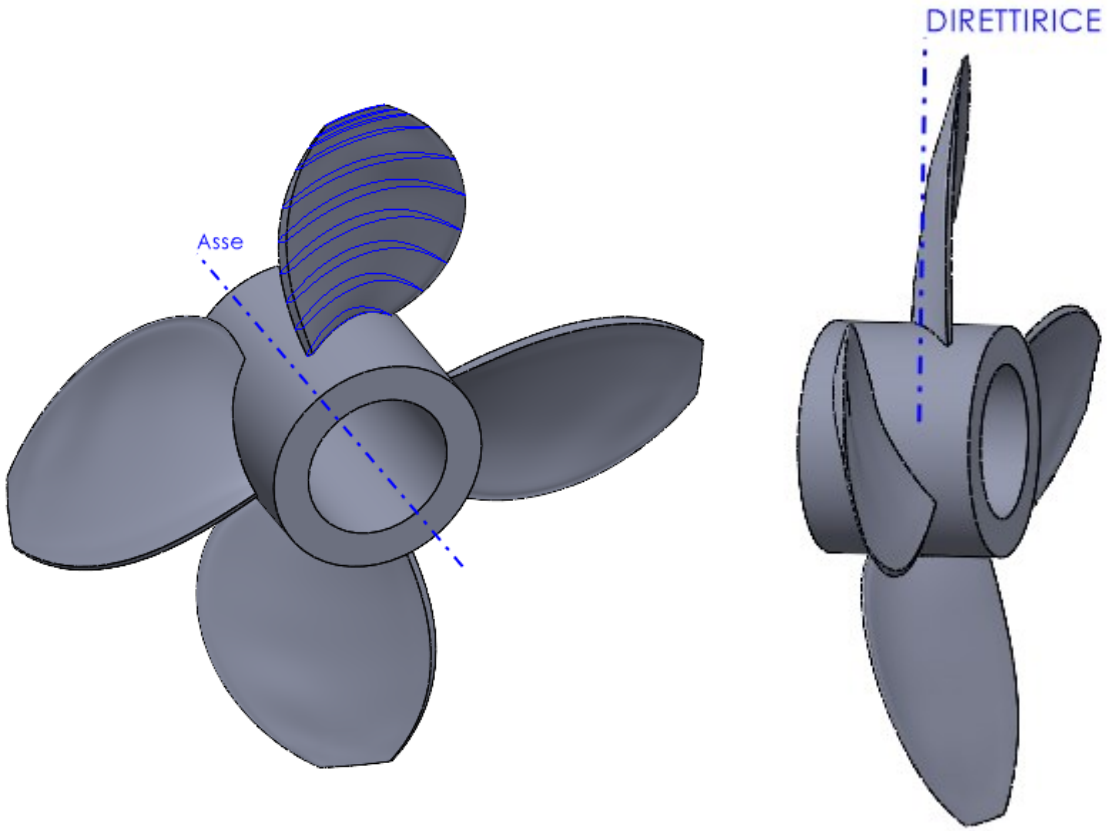






MODELLI CAD

MODELLO 1



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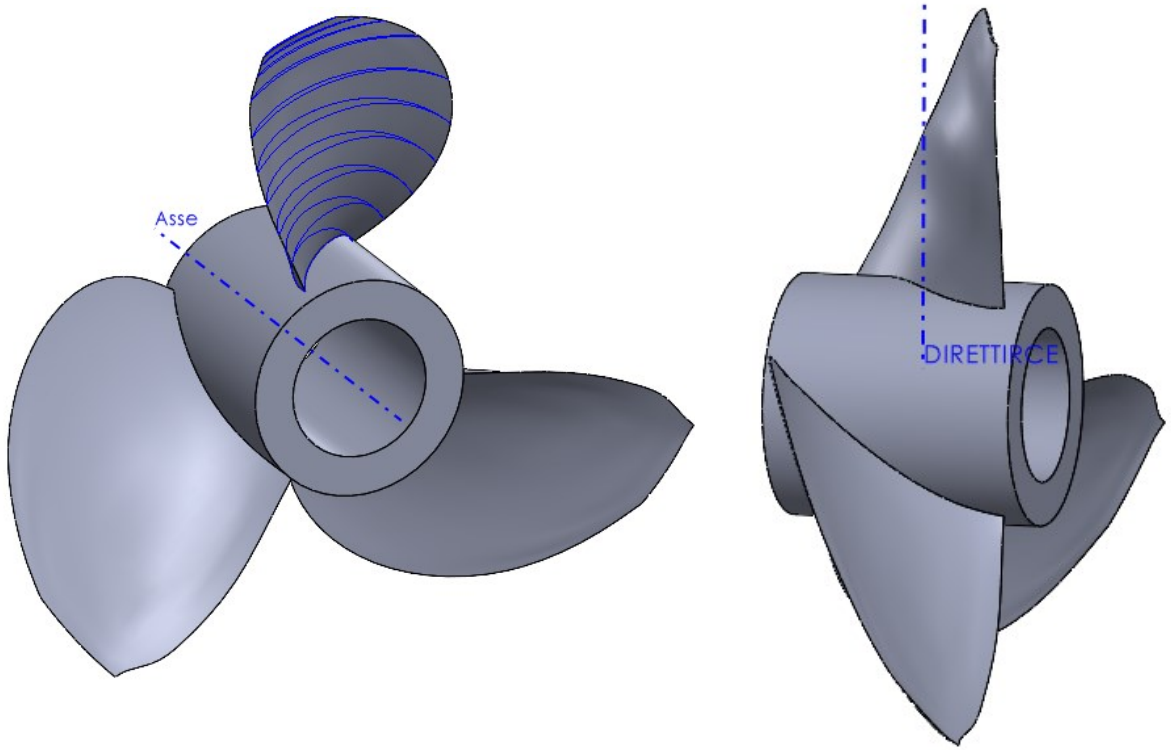

CONCLUSIONE / PROSPETTIVE FUTURE