

PUSAN NATIONAL UNIVERSITY

DEPARTMENT OF NAVAL ARCHITECTURE AND OCEAN ENGINEERING

# 프로펠러 기하학

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PROPULSOR SYSTEM LAB.

김 문 찬

Wednesday, March 07, 2012

# ✿ 날개 단면 용어

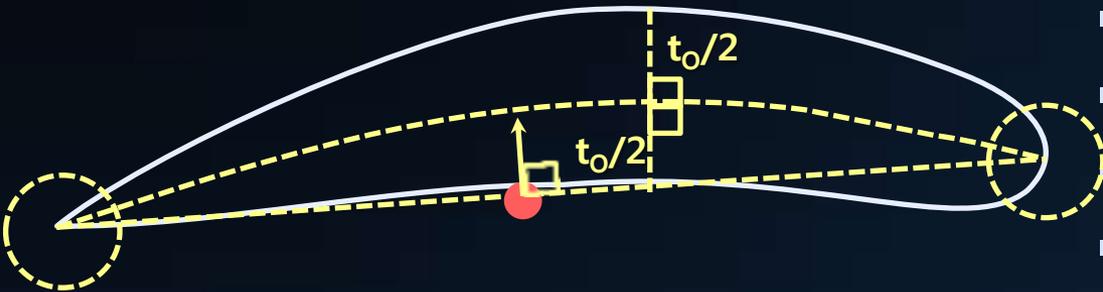


Fig 1. General definition of a propeller blade section

- Propeller blade section
- Leading edge
- Trailing edge
- Chord line
- Mean line
- Thickness
- Camber
- Blade section reference point

※ 대표단면 : Troost (Netherlands), MAU/PAI (Japan), NACA (USA), KH (Korea)

# 대표 날개 단면 비교 (MAU vs NACA)

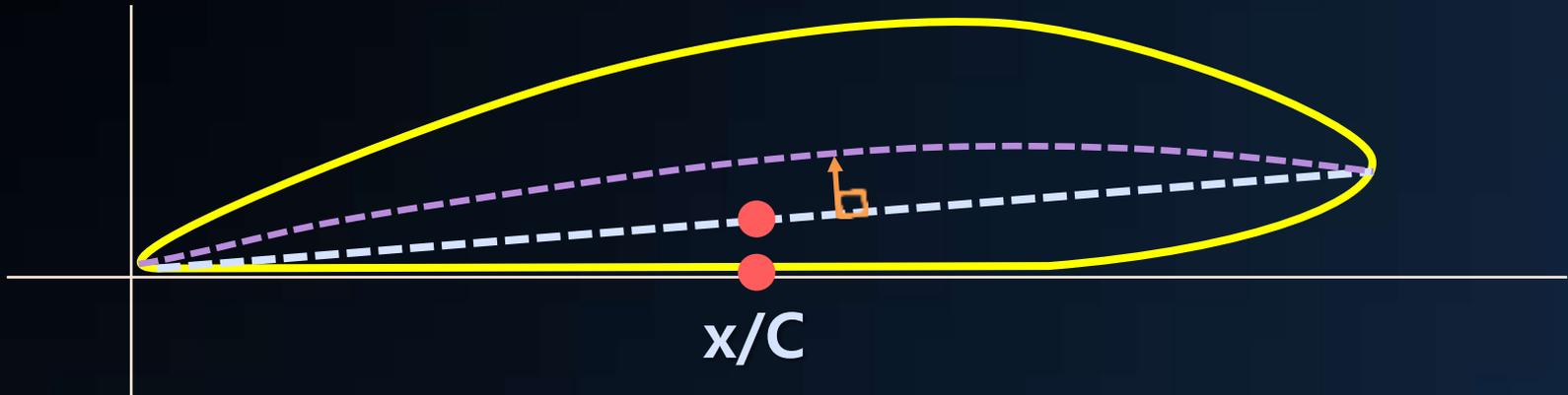


Fig 2. Definition of MAU section

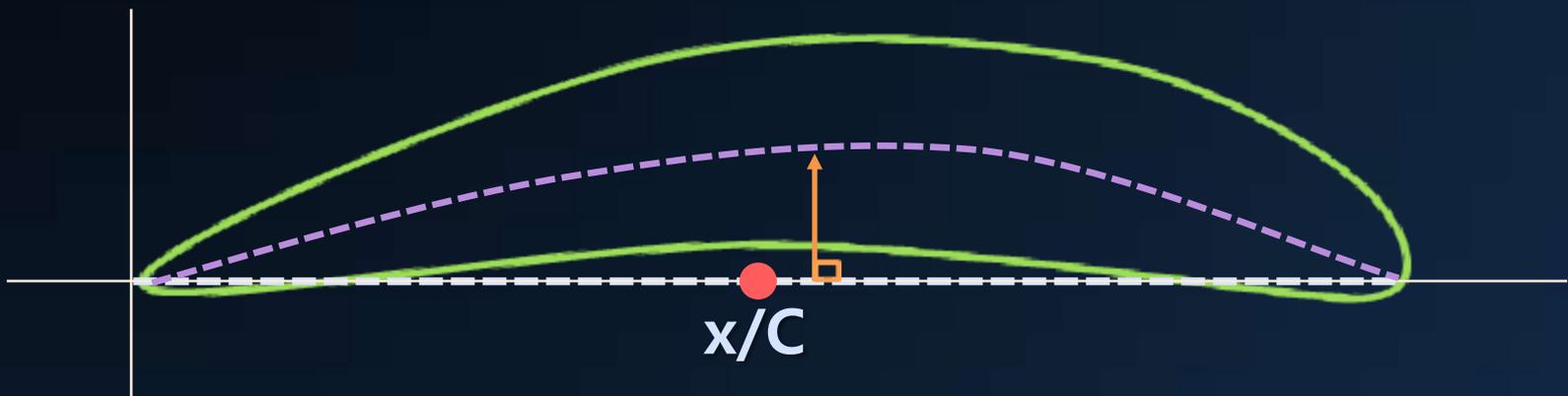
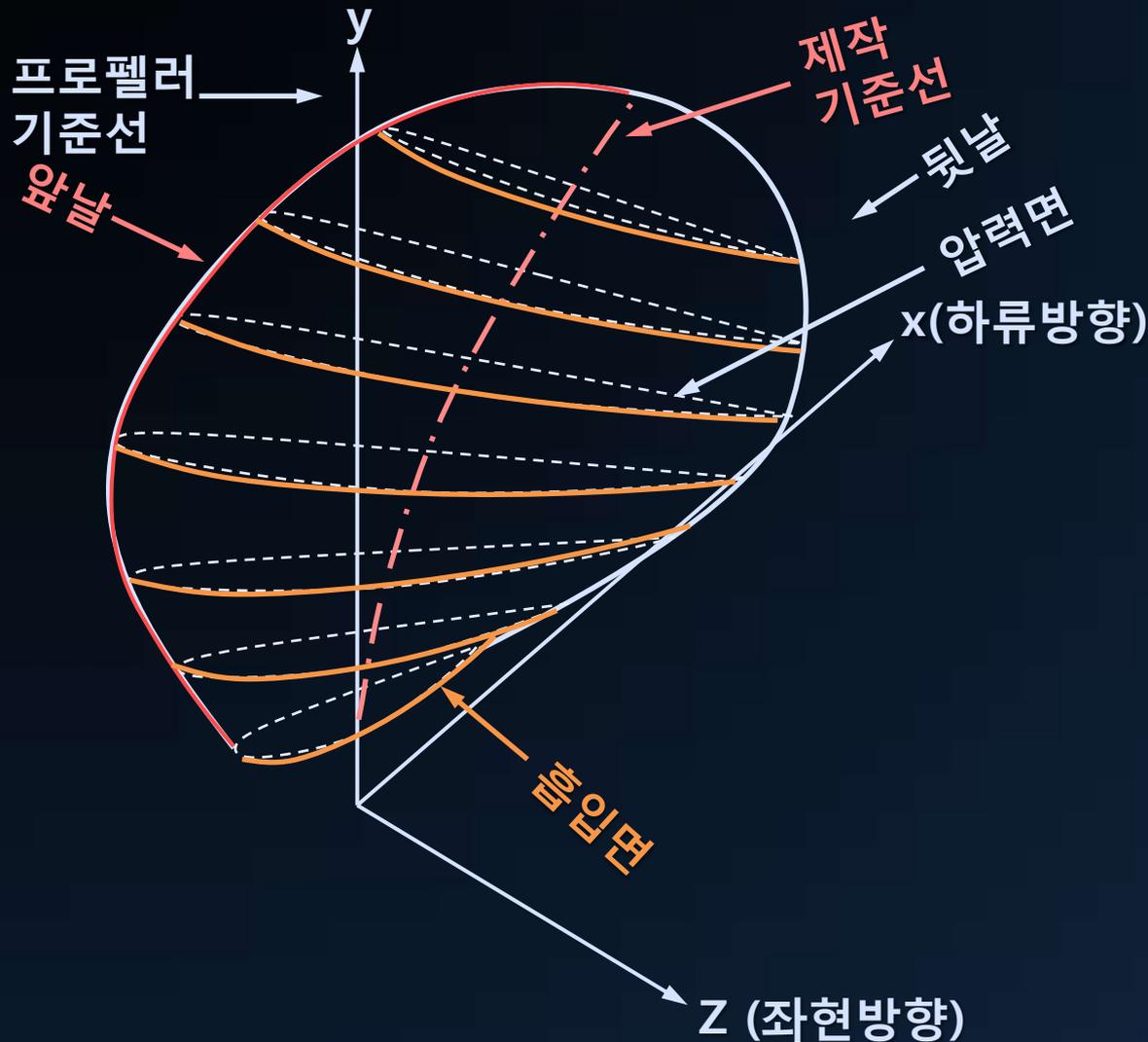


Fig 3. Definition of NACA section

Mean Line	Chord Line	Camber	Blade Section reference point
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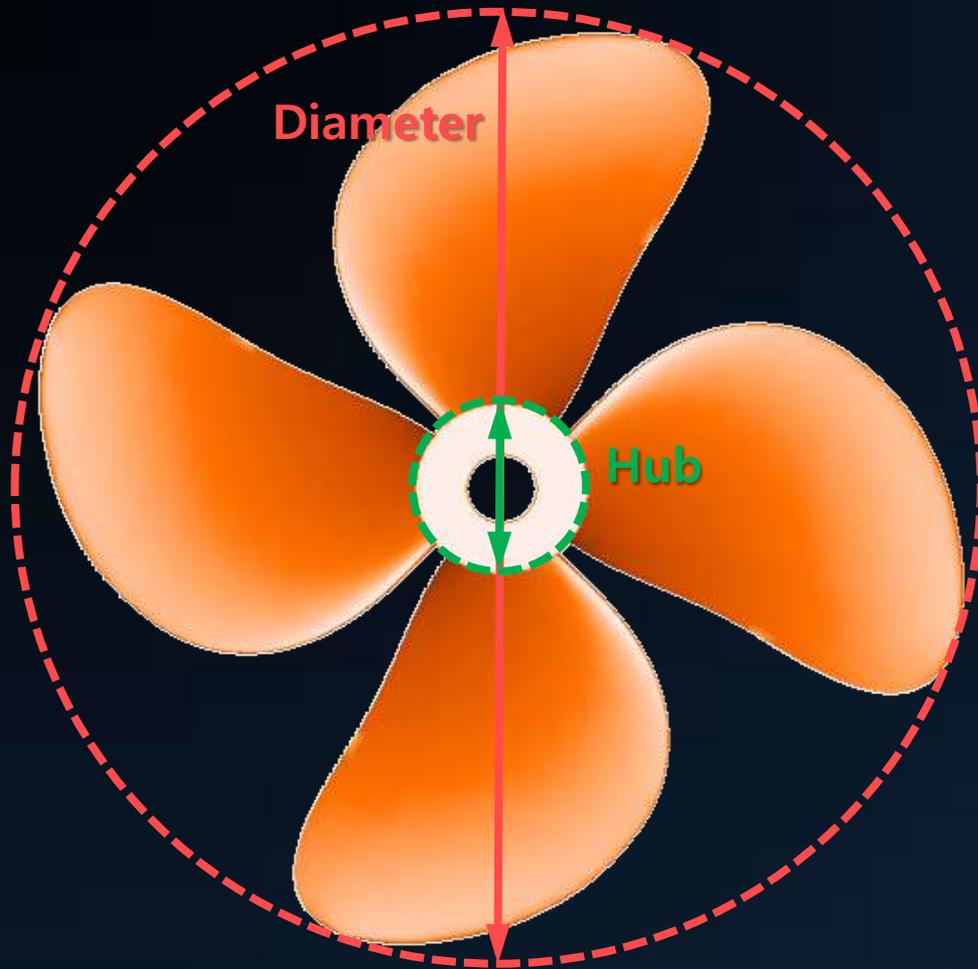
# 프로펠러 기본 용어



- Blade outline
- Propeller reference line
- Generator line
- Leading edge
- Trailing edge
- Suction side
- Pressure side

Fig 4. Definition of basic propeller geometry ( I )

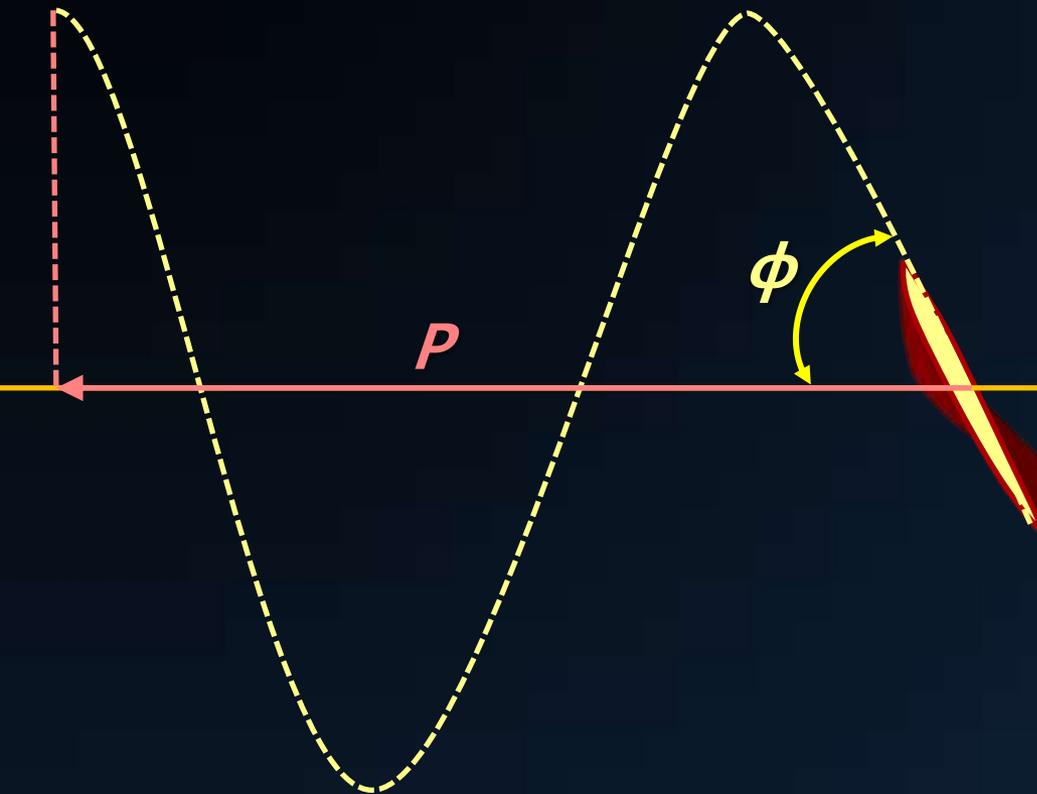
# 프로펠러 기본 용어



- Diameter,  $D$
- Hub,  $d_H$
- Pitch,  $P$
- Pitch angle,  $\phi$
- Rake,  $\alpha_G$
- Skew,  $\theta_m$
- Blade thickness,  $t_o$
  
- Pitch ratio,  $P/D$
- Hub ratio,  $d_H/D$
- Blade thickness ratio,  $t_o/D$

Fig 5. Definition of basic propeller geometry (II)

# 프로펠러 기본 용어

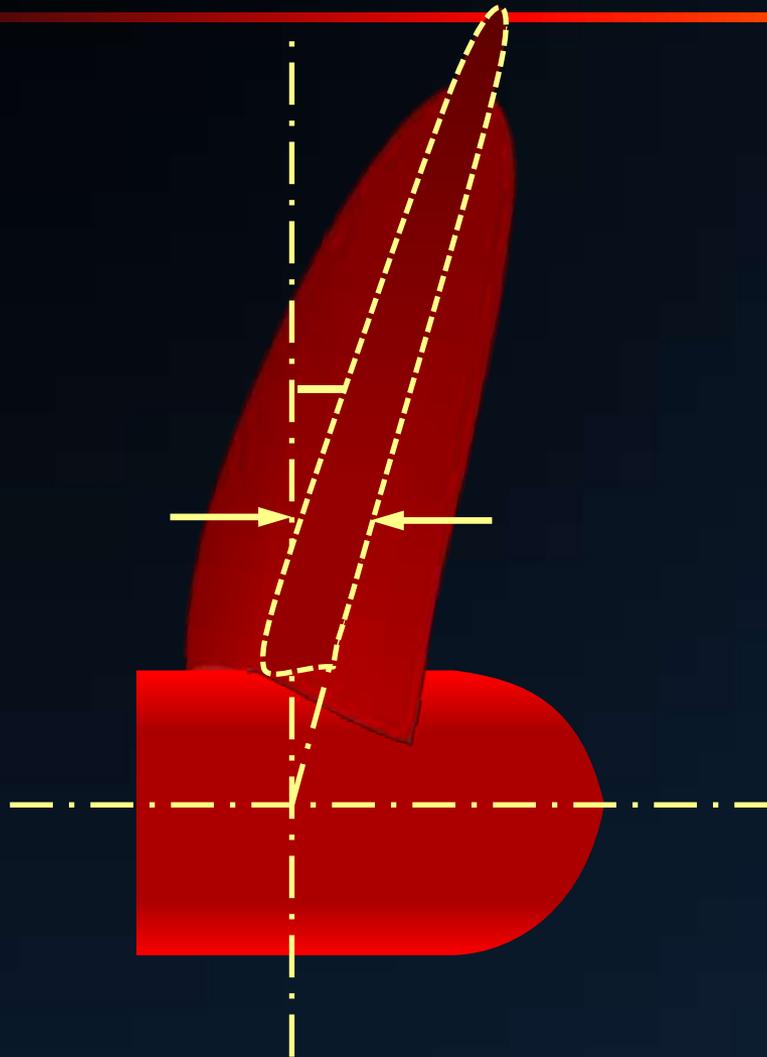


$$P = 2\pi r \tan \phi, \quad \phi = \tan^{-1} \frac{P}{2\pi r}$$

- Diameter,  $D$
- Hub,  $d_H$
- Pitch,  $P$
- Pitch angle,  $\phi$
- Rake,  $x_G$
- Skew,  $\theta_m$
- Blade thickness,  $t_o$
  
- Pitch ratio,  $P/D$
- Hub ratio,  $d_H/D$
- Blade thickness ratio,  $t_o/D$

Fig 6. Definition of basic propeller geometry (III)

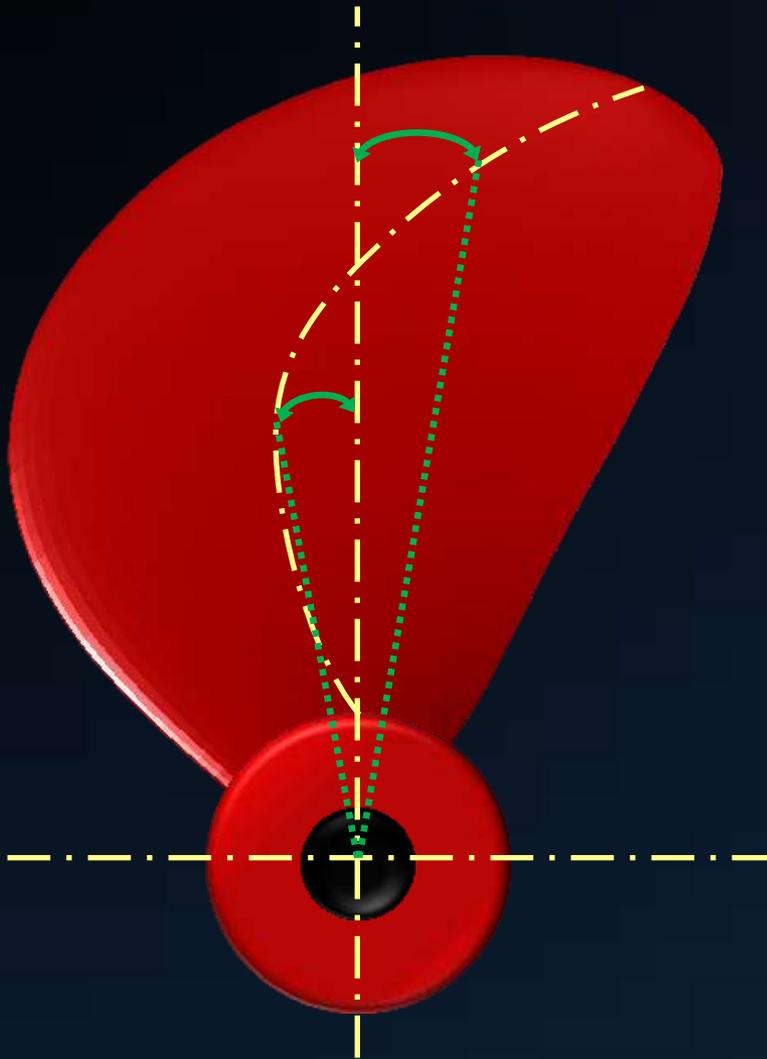
# 프로펠러 기본 용어



- Diameter,  $D$
- Hub,  $d_H$
- Pitch,  $P$
- Pitch angle,  $\phi$
- Rake,  $x_G$
- Blade thickness,  $t_0$
- Skew,  $\theta_m$
  
- Pitch ratio,  $P/D$
- Hub ratio,  $d_H/D$
- Blade thickness ratio,  $t_0/D$

Fig 7. Definition of basic propeller geometry (IV)

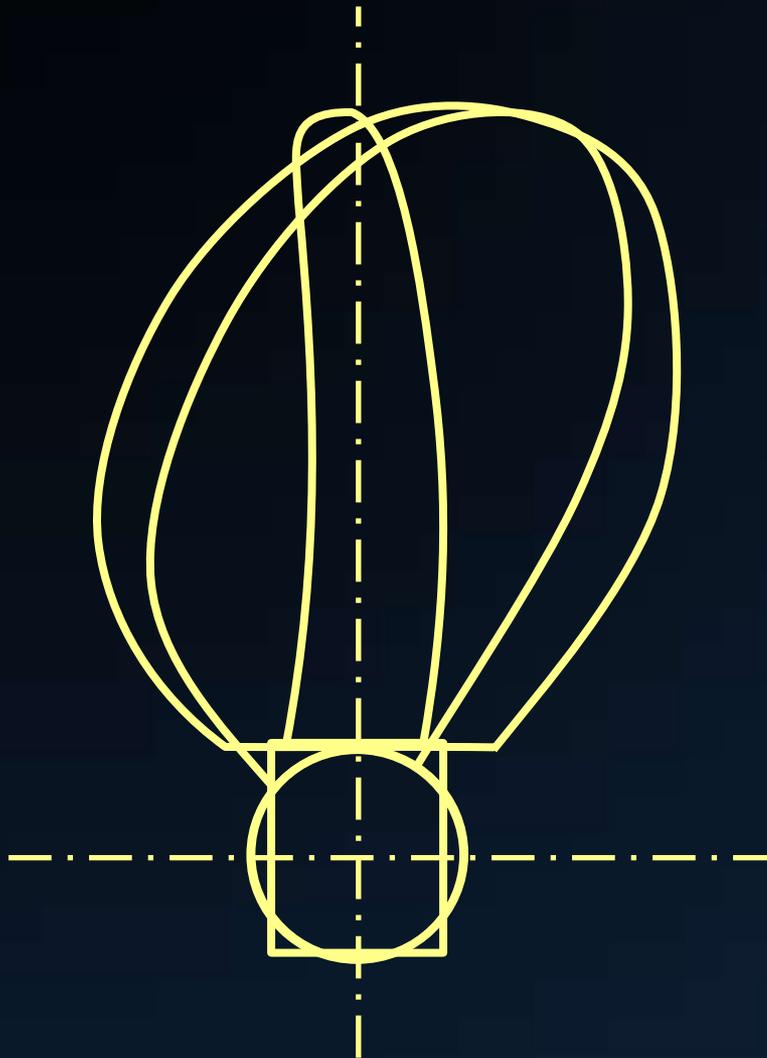
# 프로펠러 기본 용어



- Diameter,  $D$
- Hub,  $d_H$
- Pitch,  $P$
- Pitch angle,  $\phi$
- Rake,  $x_G$
- Blade thickness,  $t_o$
- Skew,  $\theta_m$
  
- Pitch ratio,  $P/D$
- Hub ratio,  $d_H/D$
- Blade thickness ratio,  $t_o/D$

Fig 8. Definition of basic propeller geometry (V)

# 프로펠러 기본 용어



- Swept outline
- Projected outline
- Expanded outline

Fig 9. Definition of basic propeller geometry (VI)

# 수식을 이용한 날개 형상 표현

- 각 반경에 대한 날개 윤곽선 좌표

$$x_{l,t} = x_G + r\theta_m \tan\phi \mp \frac{c}{2} \sin\phi$$

$$\theta_{l,t} = \theta_m \mp \frac{c}{2r} \cos\phi$$

$$y_{l,t} = r \cos\theta_{l,t}$$

$$z_{l,t} = r \sin\theta_{l,t}$$

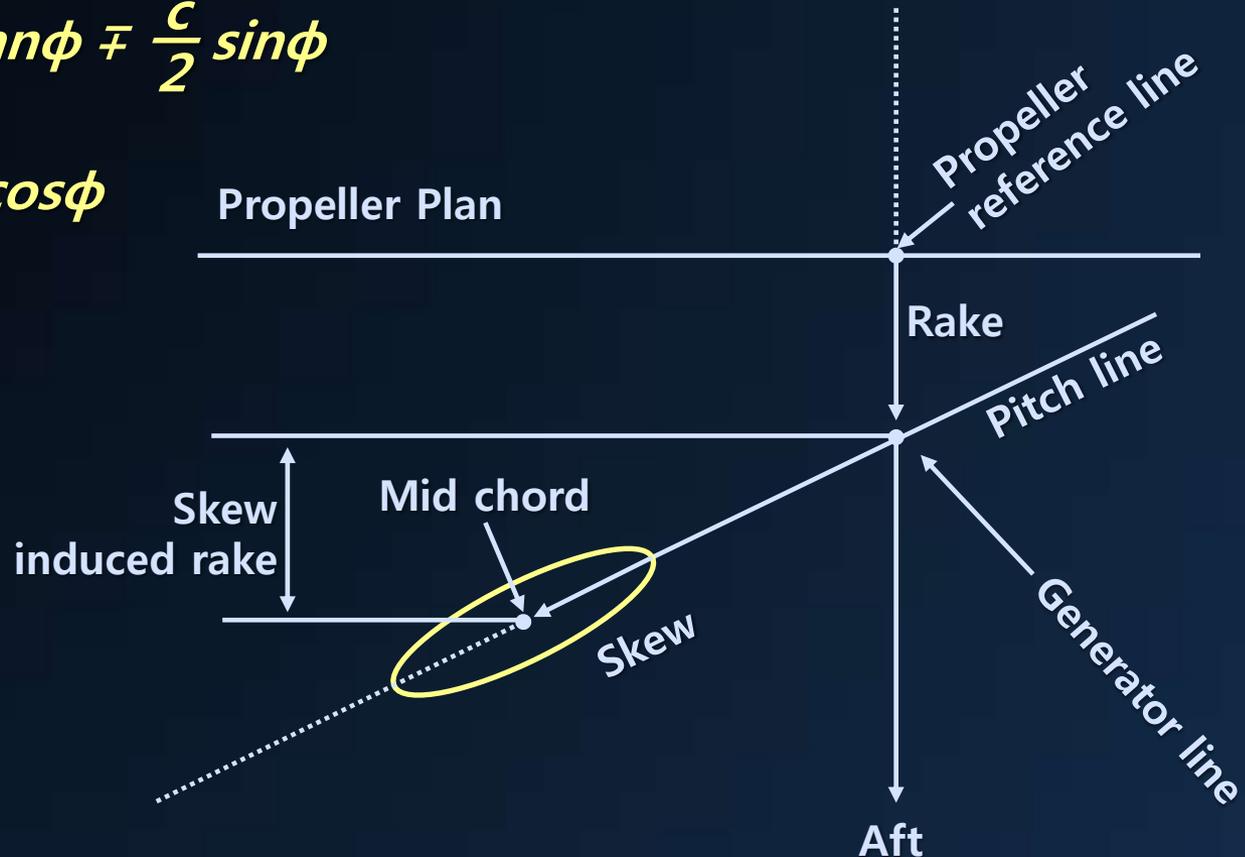


Fig 10. Propeller geometry in x-rθ coordinate ( I )

# 수식을 이용한 날개 형상 표현

- 날개수가 Z인 프로펠러의 3차원 형상 좌표

$$\delta_k = \frac{2\pi(k-1)}{Z}, \quad k=1, \dots, Z$$

$$x^\pm = x_G + r\theta_m \tan\phi + c\left(s - \frac{1}{2}\right)\sin\phi - f\cos\phi \mp \frac{t}{2}\cos\psi$$

$$\theta^\pm = \theta_m + c\left(s - \frac{1}{2}\right)\frac{\cos\phi}{r} + \frac{f\sin\phi}{r} \pm \frac{\frac{1}{2}\sin\psi}{r} + \delta_k$$

$$y^\pm = r\cos\theta^\pm$$

$$z^\pm = r\sin\theta^\pm$$

# 수식을 이용한 날개 형상 표현

- 프로펠러 날개 상의 임의의 점에 대한 축방향 좌표 계산 예

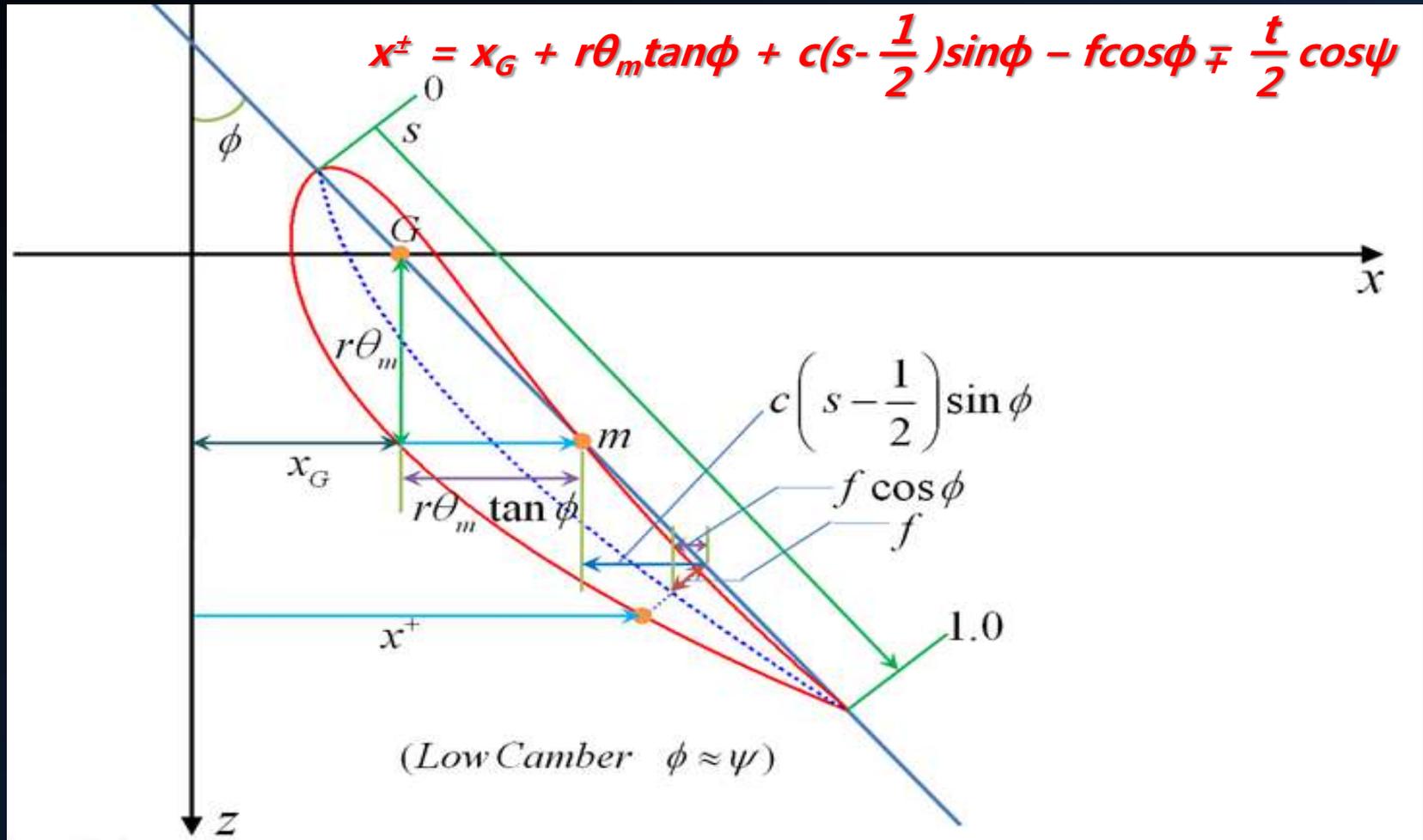
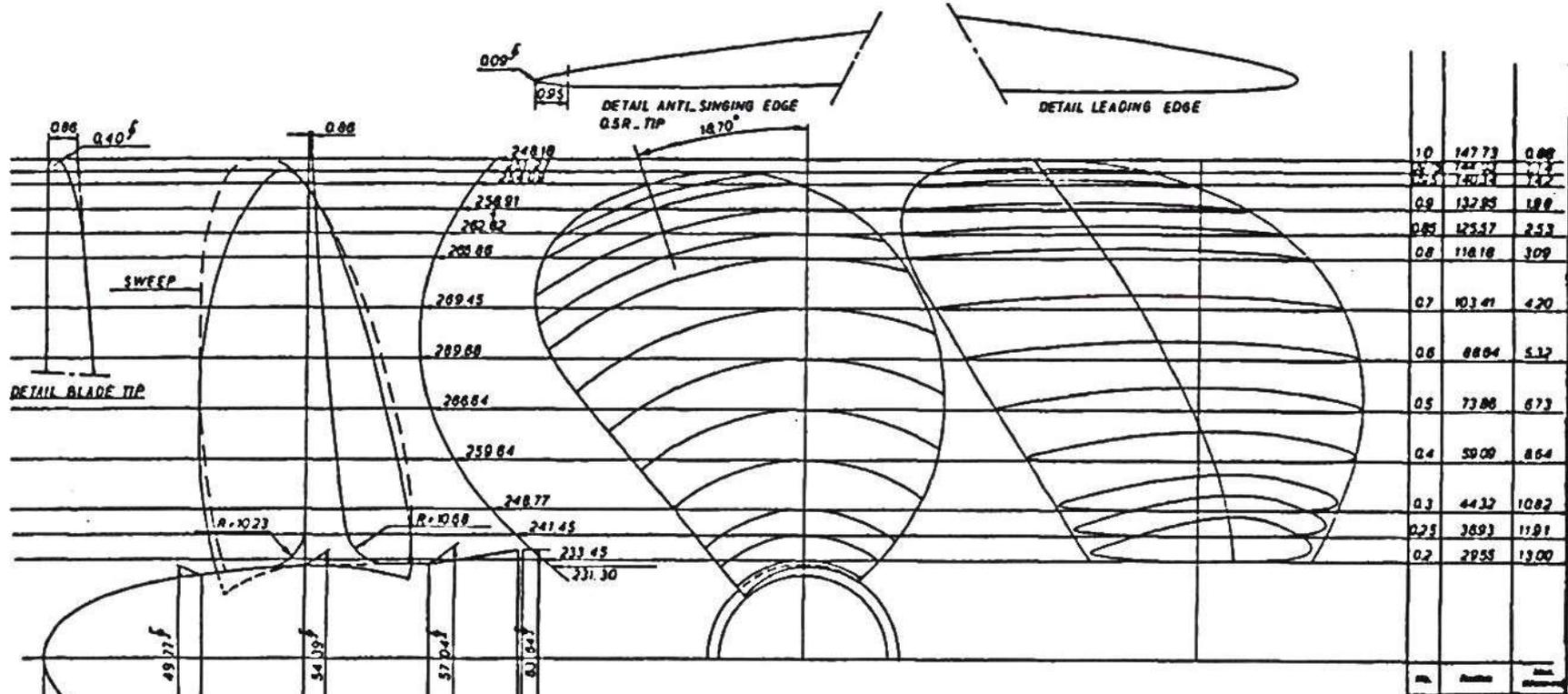


Fig 11. Propeller geometry in  $x$ - $r\theta$  coordinate (II)



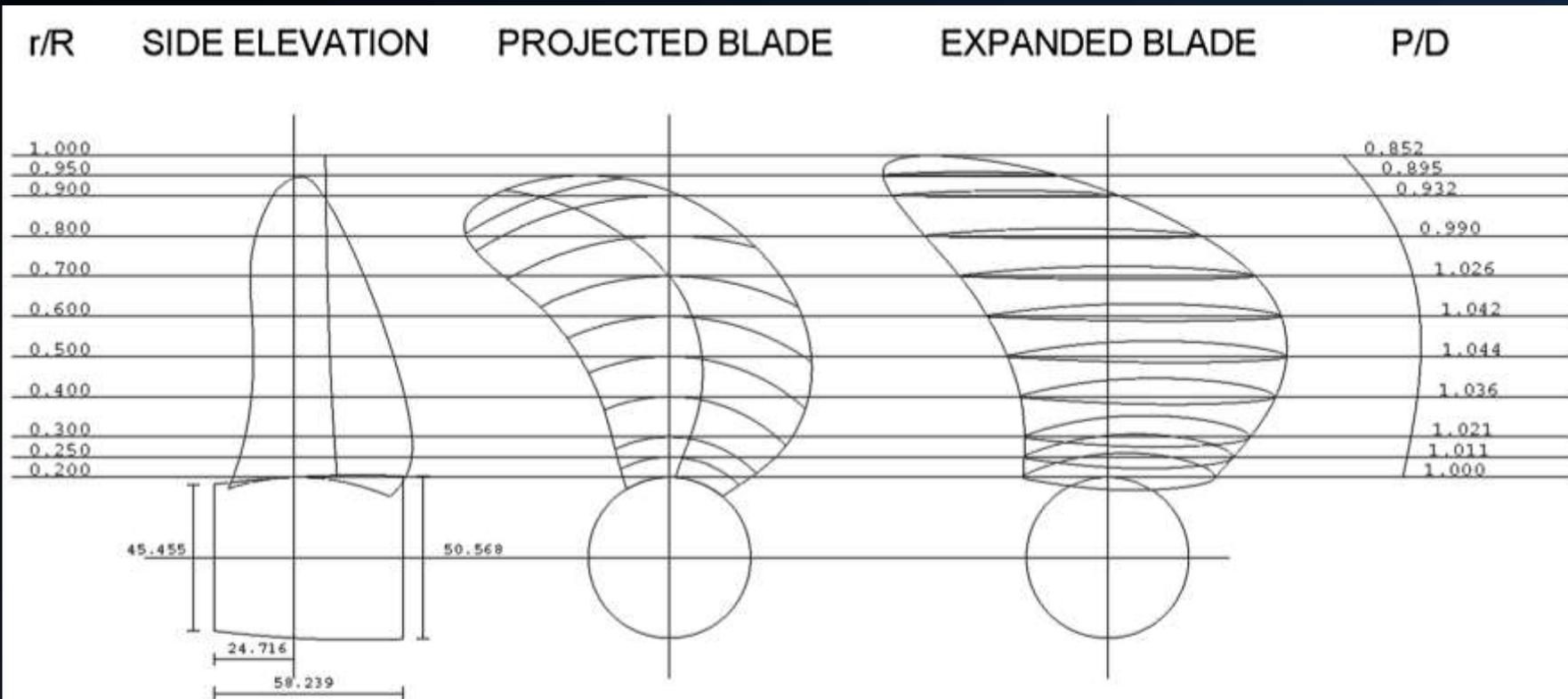
# 프로펠러 도면 예 (MAU)



PARTICULARS OF PROPELLER				NOTES
FULL SIZE		MODEL		1 RIGHT HAND PROPELLER 1 ROPE GUARD 1 CAP  ORD NO. P. 500-49  PROPELLER MODEL No. 5348
Diameter	D = 6500 mm	Material:	CUNIAL	
Pitch at root	= 5089 mm	$\phi D$	= 0.184	Pitch at root = 231.30 mm
Pitch at 6/7 R	$P_{6/7} = 5928$ mm	$P_{6/7} \phi D$	= 0.912	Pitch at 6/7 R = 269.45 mm
Pitch at blade tip	= 5480 mm	$A_d/A_0$	= 0.708	Pitch at blade tip = 248.18 mm
Disc area	$A_0 = 33183$ sq ft	$A_d/A_0$	= 0.620	$d$ = Blade diameter
Exp. blade area	$A_1 = 23522$ sq ft			Ship model No. 5492
Prof. blade area	$A_2 = 20500$ sq ft			Scale ratio 1 = 22
Number of blades	Z = 4			Drawing No. M 5492-14



# 프로펠러 도면 예 (NACA 66)



Propeller Principal Particulars					
Diameter(mm)	8800.0	Model Diam(mm)	250.000	Scale Ratio	35.2000
(P/D)mean	0.9900	(Rake/D) Tip	-0.0352	Prop. Type	FPP
Ae/Ao	0.9445	Eff. skew(Deg)	35.00	Drawing Scale	1.80556
Hub Ratio	0.2000	(C/D) 0.7R	0.3633	Comment	
No. of Blade	6	(F0/C) 0.7R	0.0106	Prop. Number	
Section	NACA66	(T/D) 0.7R	0.0165	C N U	