

ÇAPRAZ AKIŞLI RÜZGÂR TÜRBİNİ BAŞARIMININ İNCELENMESİ

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**3. İZMİR RÜZGÂR
SEMPOZYUMU ve SERGİSİ**
8-9-10 Ekim 2015



Sunum içeriđi

➤ GİRİŞ

➤ SAYISAL ÇALIŞMA

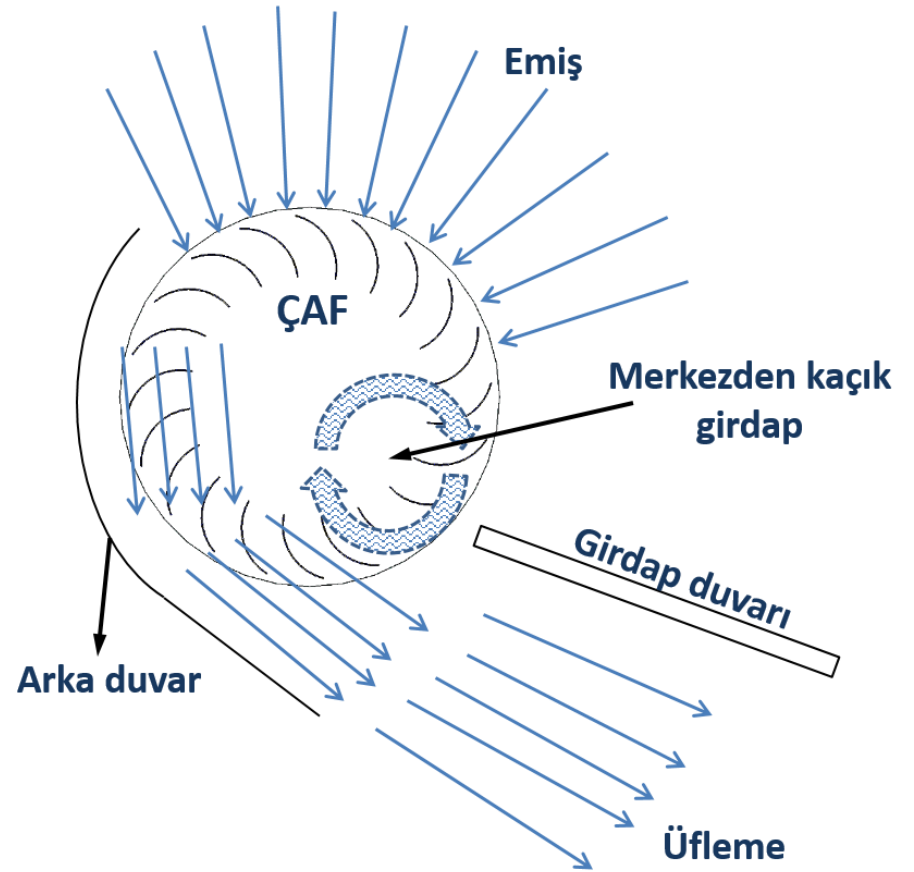
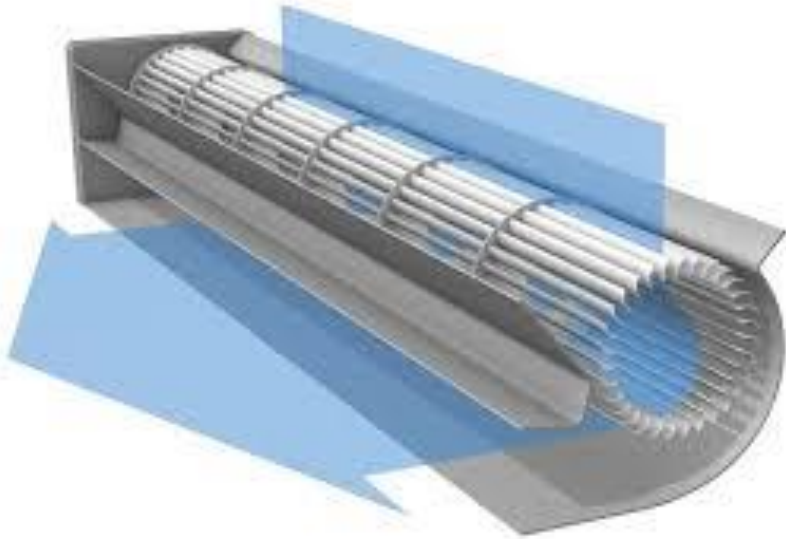
➤ BULGULAR VE DEĞERLENDİRME

➤ SONUÇ

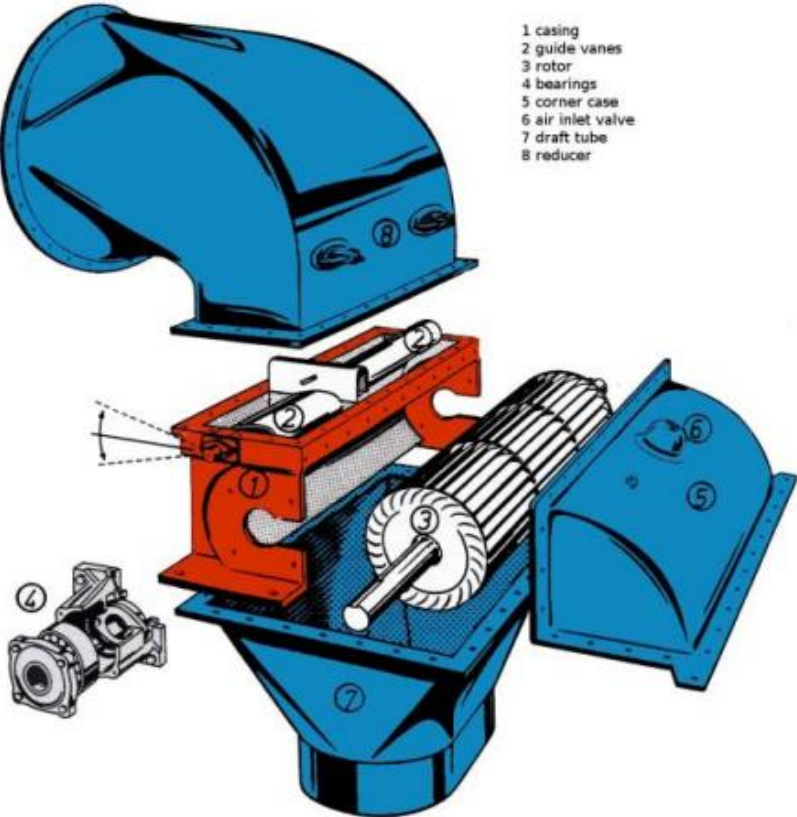
Giriş – Çapraz akışlı fanlar/ Çapraz akışlı türbinler

Çapraz akışlı fanlar;

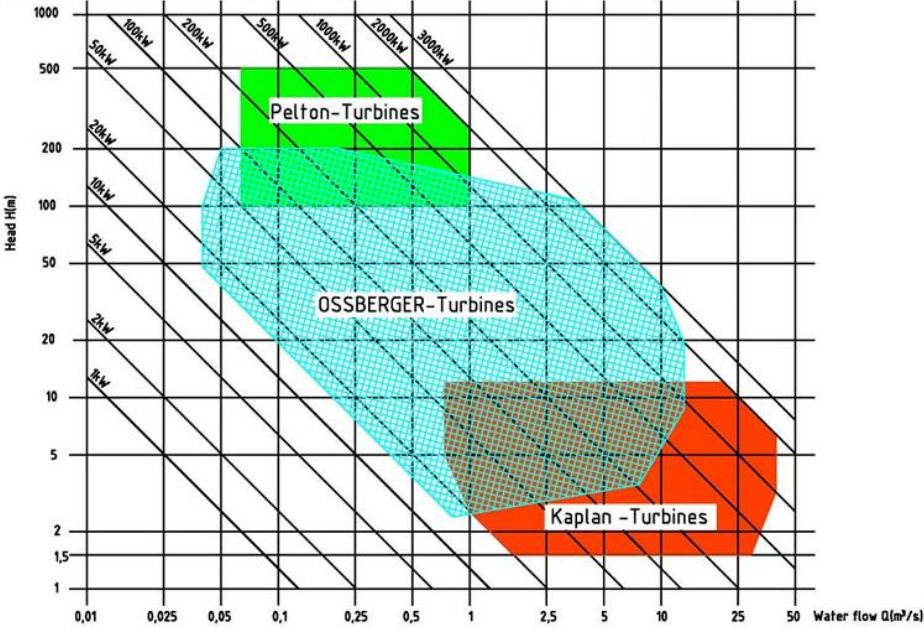
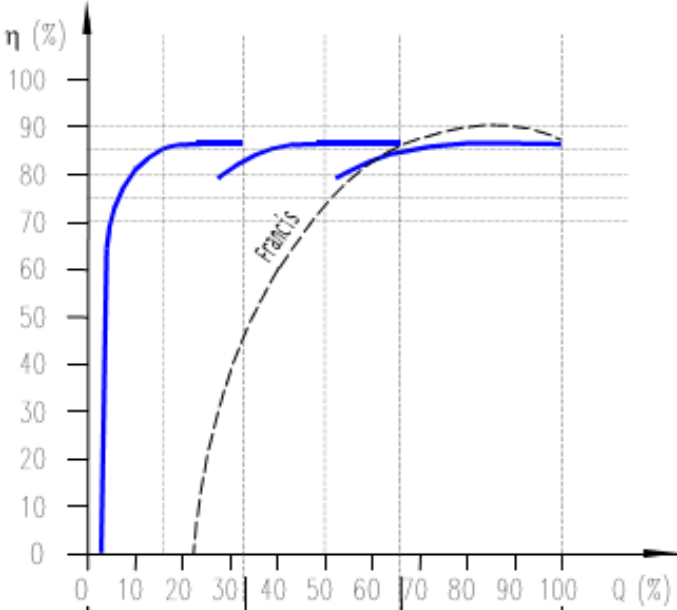
- Modüler yapı
- Debi ayarlama kolaylığı
- Dar alanda yüksek debi
- Düşük ses
- ...



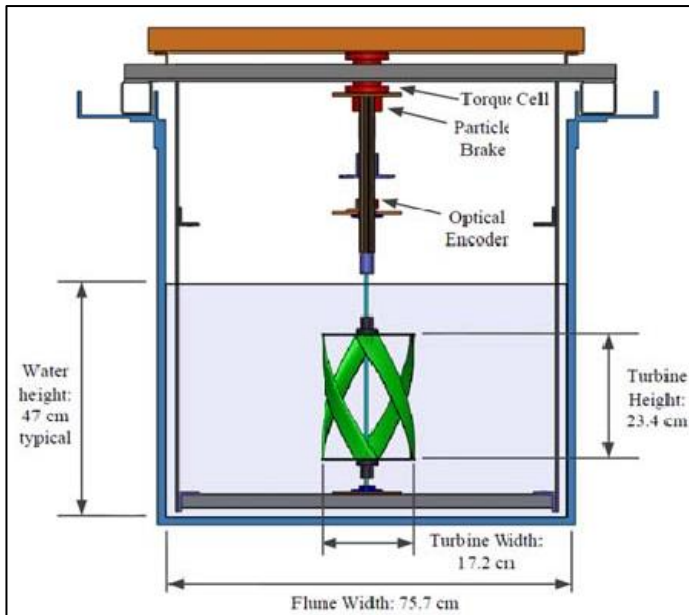
Giriş –Çapraz akışlı su türbinleri



Picture 4 Design of a two-cell OSSBERGER Turbine



Giriş –Çapraz akışlı su türbinler



Proceedings of the 1st Marine Energy Technology Symposium
 METS13
 April 10-11, 2013, Washington, D.C.

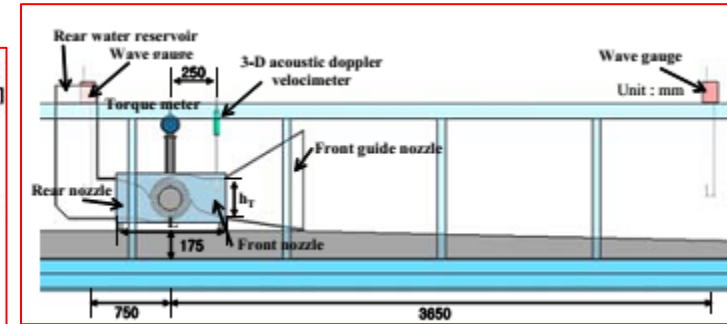
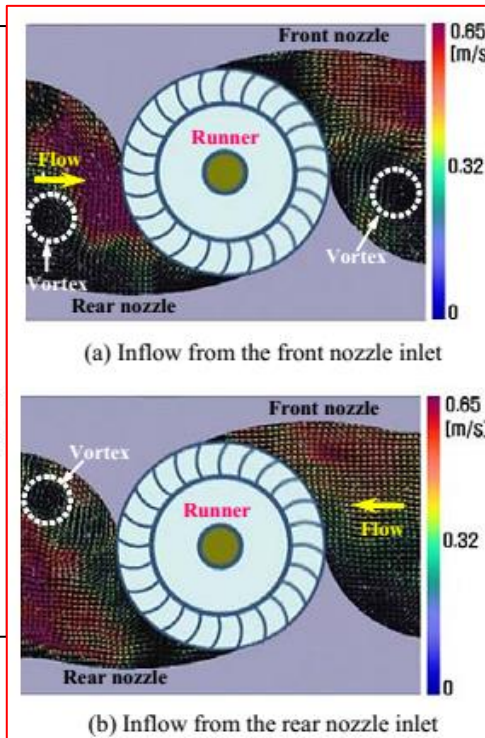
CROSS-FLOW TURBINE PERFORMANCE AND WAKE CHARACTERIZATION

Brian Polagye ¹ University of Washington, NNMREC Seattle, WA, USA	Robert Cavagnaro University of Washington, NNMREC Seattle, WA, USA	Adam Niblick Creare, Inc. Hanover, NH, USA
Taylor Hall Battelle Memorial Institute Columbus, OH, USA	Jim Thomson University of Washington, NNMREC Seattle, WA, USA	Alberto Aliseda University of Washington, NNMREC Seattle, WA, USA

Performance Improvement of a Micro Eco Cross-Flow Hydro Turbine

Kiyoshi Kokubu¹ · Toshiaki Kanemoto² · Sung-Woo Son³ · Young-Do Choi[†]

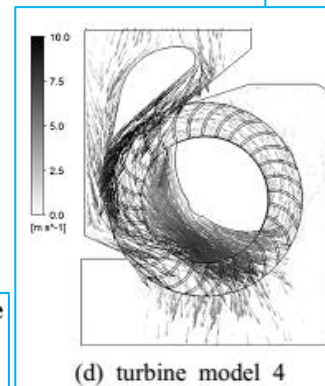
Journal of the Korean Society of Marine Engineering, Vol. 36, No. 7, pp. 902~909, 2012(ISSN 1226-9549)



Effect of wave conditions on the performance and internal flow of a direct drive turbine[†]

Young-Do Choi¹, Chang-Goo Kim² and Young-Ho Lee^{3,*}

Journal of Mechanical Science and Technology 23 (2009) 1693~1701



(d) turbine model 4

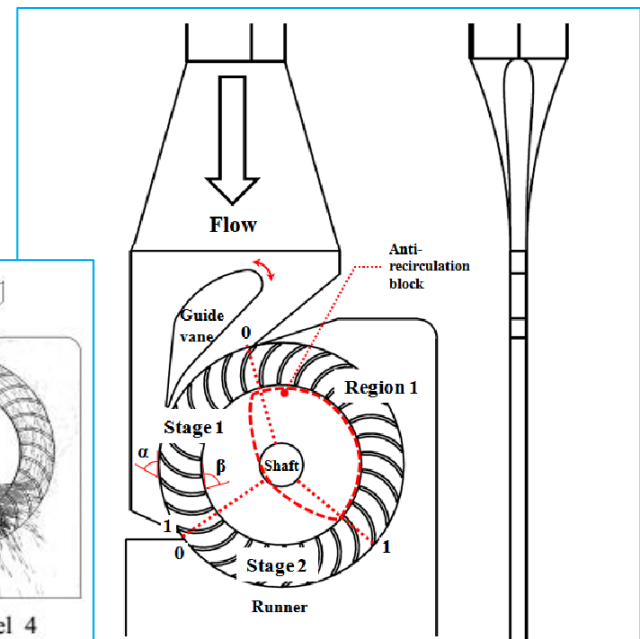
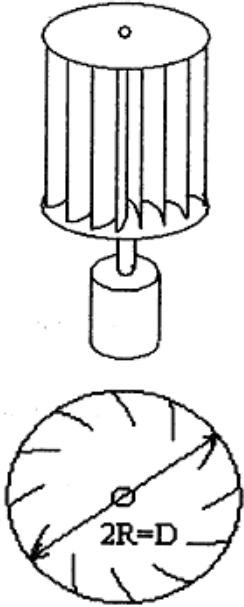


Figure 1: Schematic view of ECFT model.

Giriş –Çapraz akışlı rüzgar türbinleri

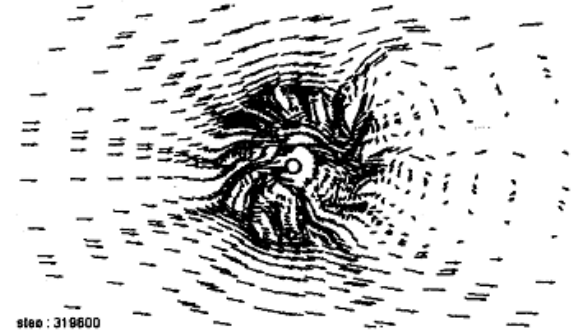
KAWAMURA, Tetuya; SATO, Yuko. Numerical simulation of the flow around cross-flow wind turbine. Research Institute of Mathematical Science Departmental Bulletin Paper, Kyoto University, Japan, 2002, 1288.5: 44-51.



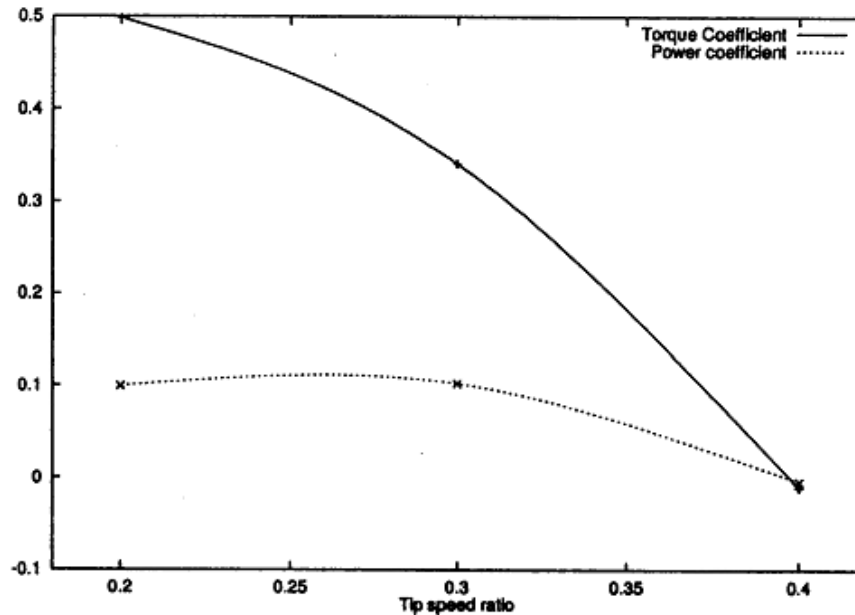
12 kanatlı



(a) Pressure field at $\theta = 10^\circ$



(b) Velocity field at $\theta = 10^\circ$



Giriş –Çapraz akışlı rüzgar türbinleri

TANINO, Tadakazu; NAKAO, Shinichiro; UEBAYASHI, Genki. Improving ambient wind environments of a cross-flow wind turbine near a structure by using an Inlet Guide Structure and a Flow Deflector. Journal of Thermal Science, 2005, 14.3: 242-248.

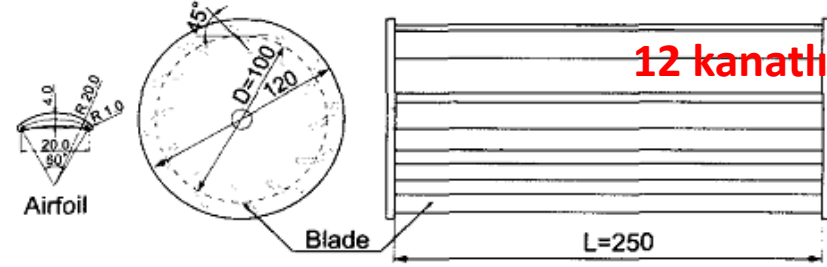
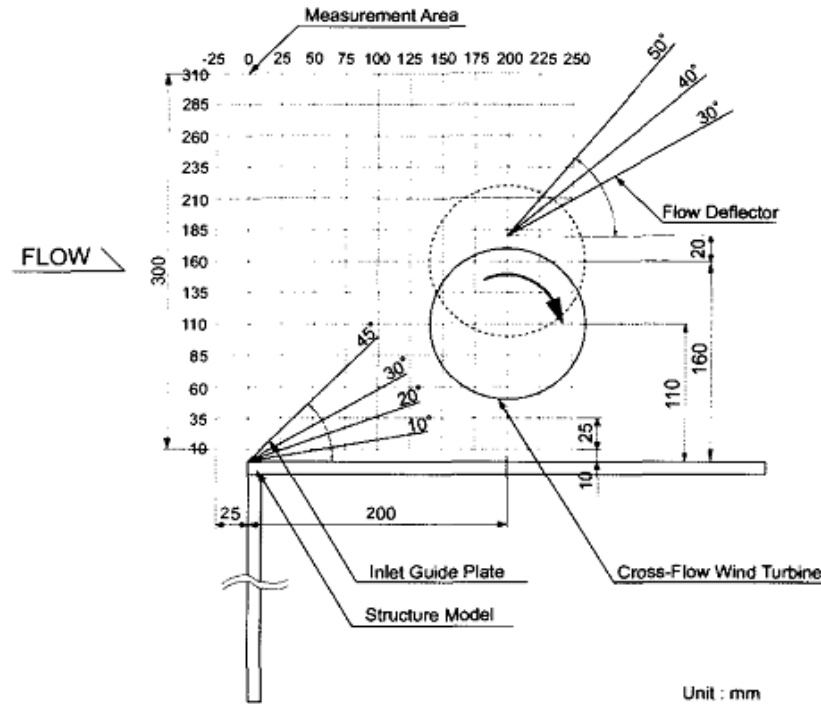
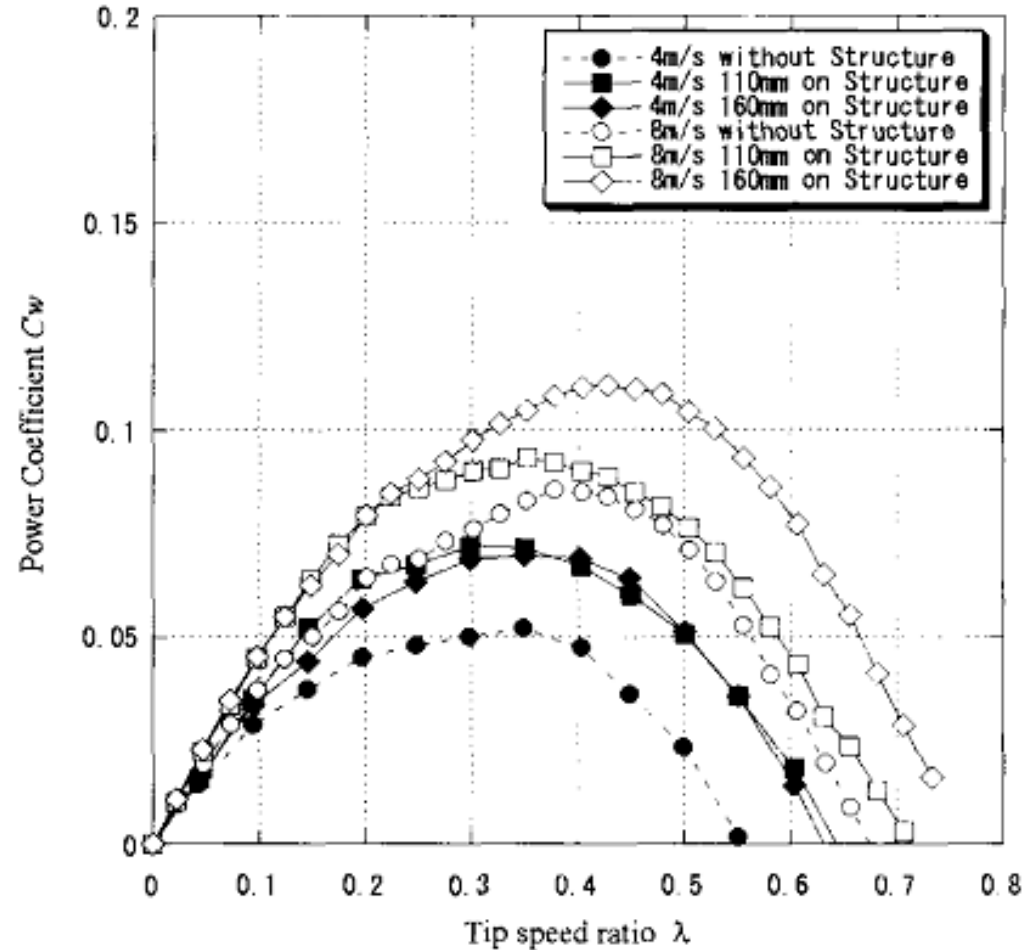


Fig.1 Schematic of cross-flow wind turbine test model



Performance Curves (with/without Structure)



Bir yapıya yakın yerleşimde güç katsayısı %30 artıyor

Giriş –Çapraz akışlı rüzgar türbinleri

TANINO, Tadakazu; NAKAO, Shinichiro; UEBAYASHI, Genki. Improving ambient wind environments of a cross-flow wind turbine near a structure by using an Inlet Guide Structure and a Flow Deflector. Journal of Thermal Science, 2005, 14.3: 242-248.

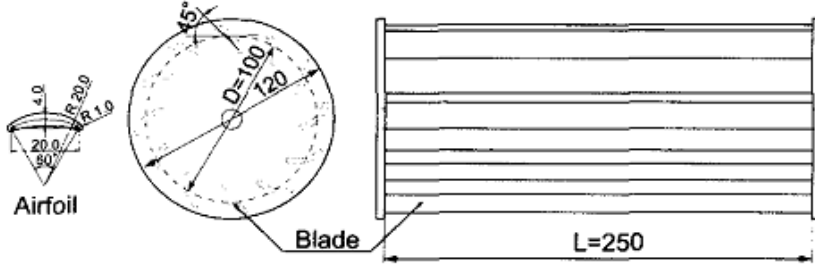
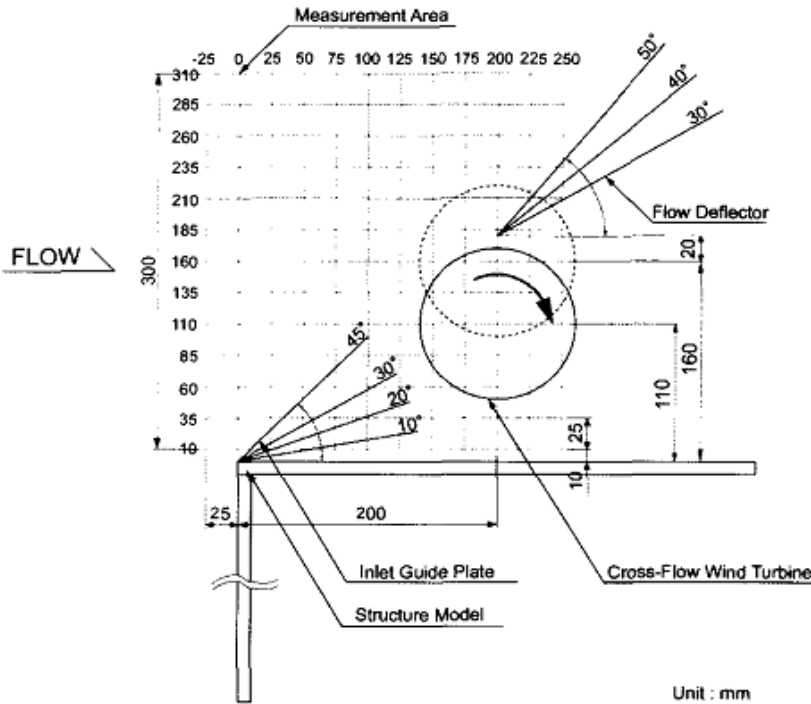
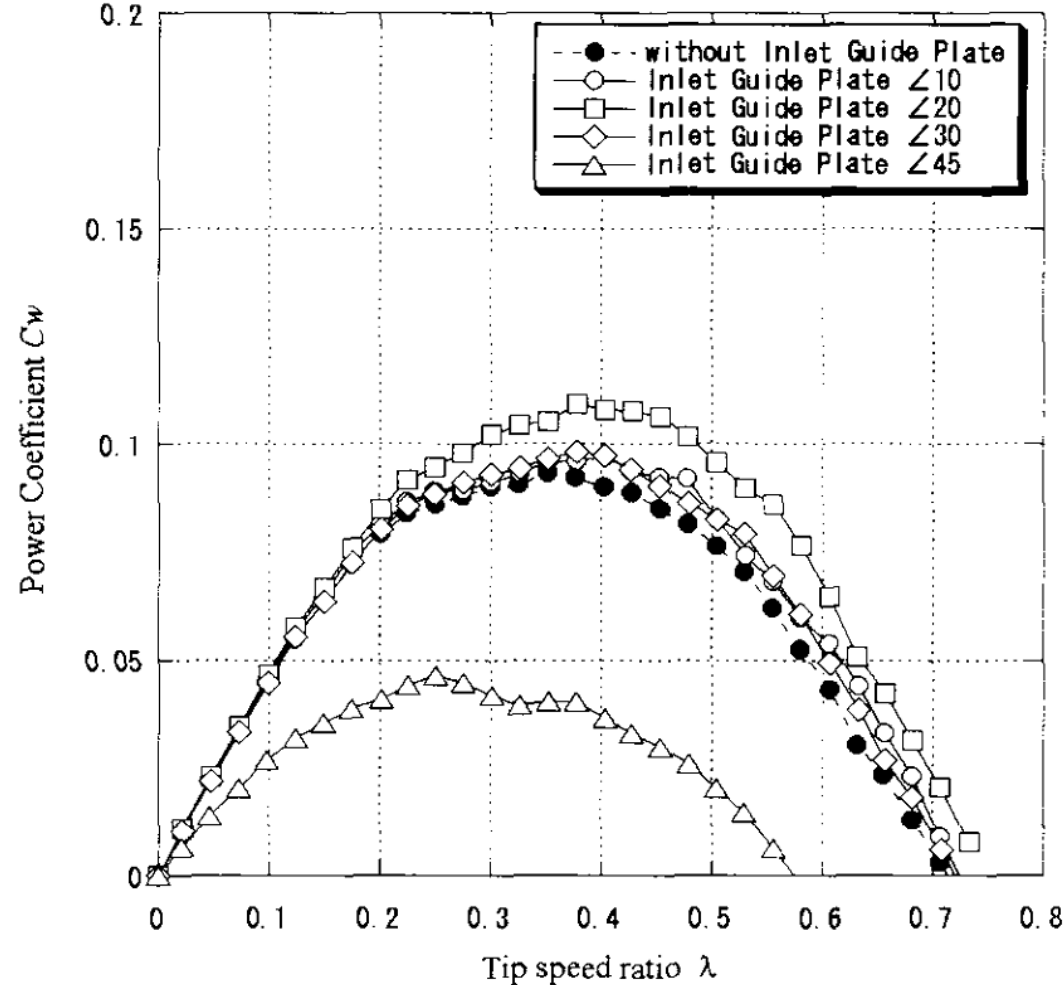


Fig.1 Schematic of cross-flow wind turbine test model



Performance Curves (8m/s, with/without Inlet Guide Plate)



Akım tarafına yerleştirilen yönlendirici olumlu veya olumsuz etki oluşturabilir

Giriş –Çapraz akışlı rüzgar türbinleri

TANINO, Tadakazu; NAKAO, Shinichiro; UEBAYASHI, Genki. Improving ambient wind environments of a cross-flow wind turbine near a structure by using an Inlet Guide Structure and a Flow Deflector. Journal of Thermal Science, 2005, 14.3: 242-248.

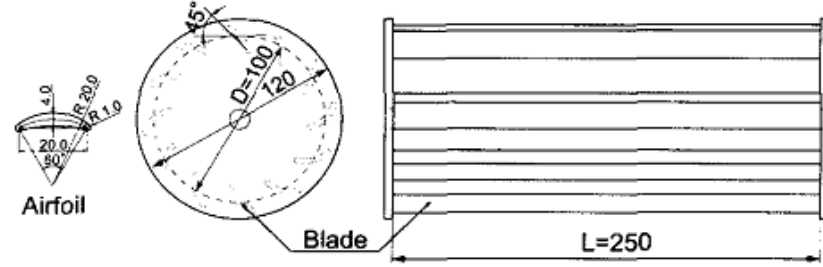
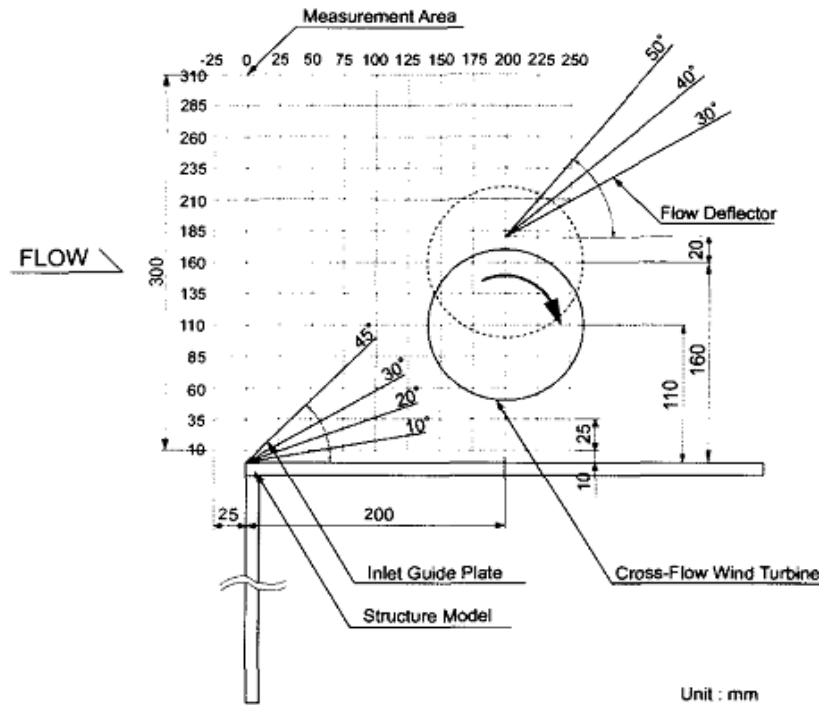
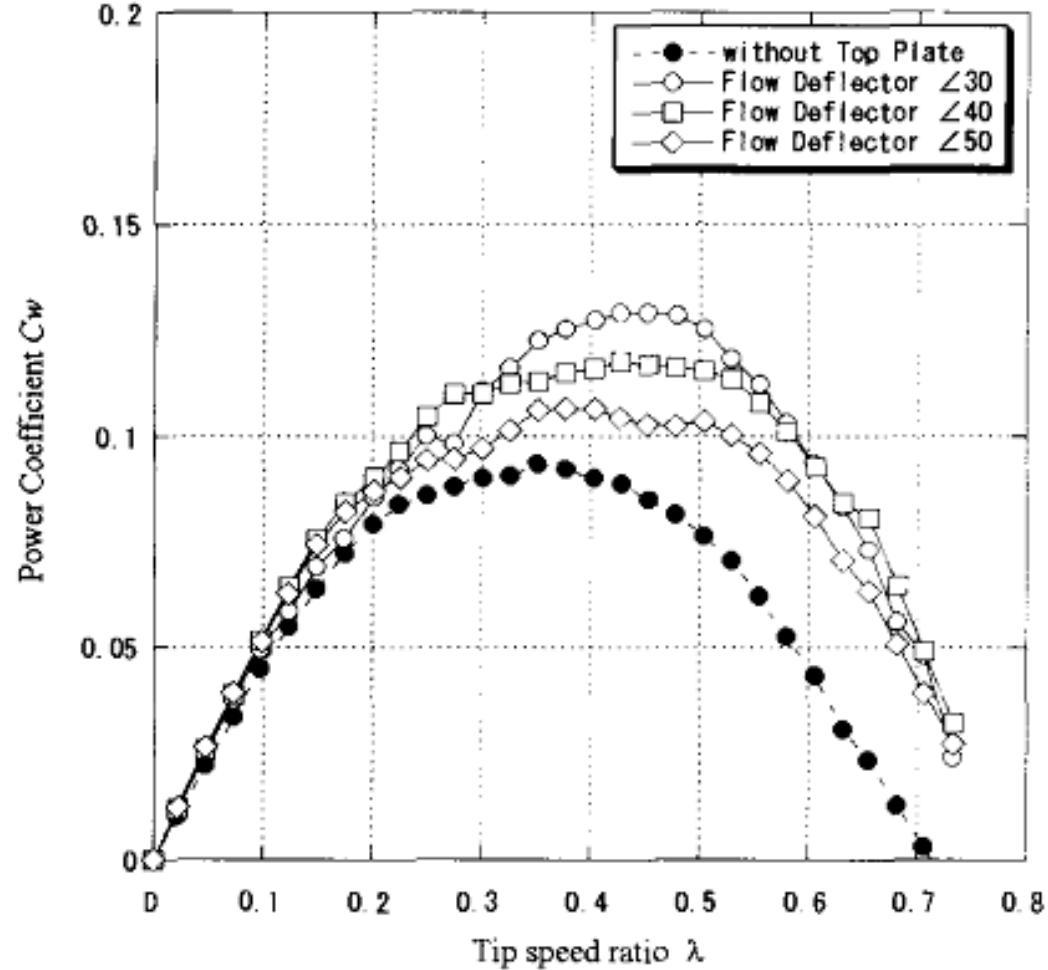


Fig.1 Schematic of cross-flow wind turbine test model



Unit : mm

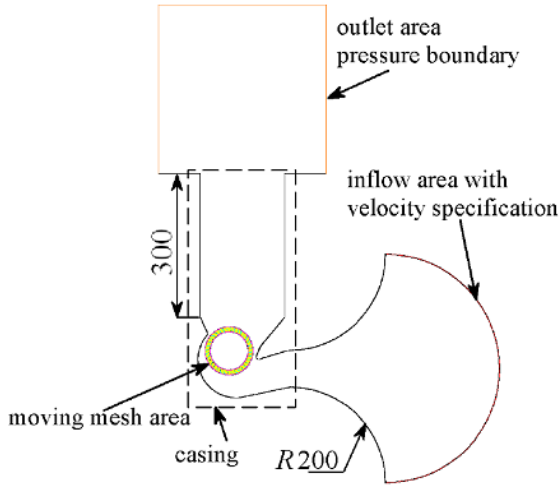
Performance Curves (8m/s, with/without Flow Deflector)



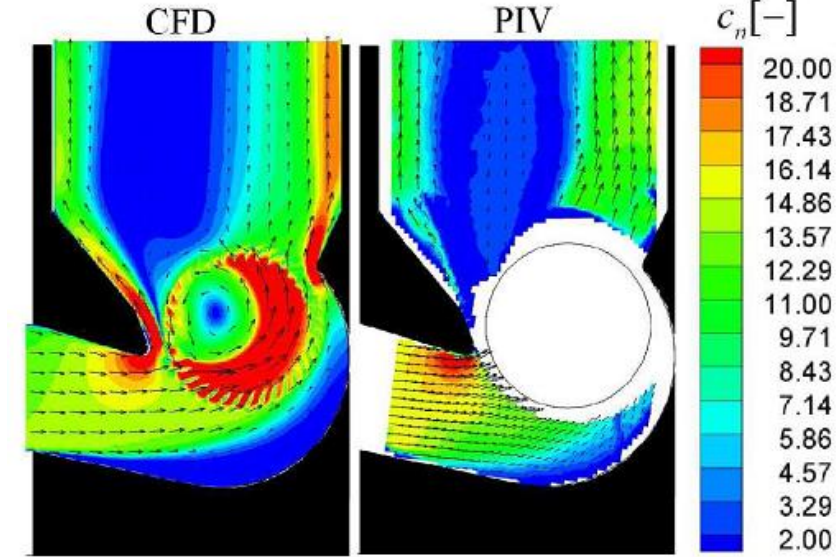
Akış saptırıcı %40'a kadar daha yüksek başarımlı sağlayabiliyor

Giriş –Çapraz akışlı rüzgar türbinleri

KLEMM, Toni; GABI, Martin; HERAUD, Jean-Nicolas. Application of a cross flow fan as a wind turbine. Journal of Computational and Applied Mechanics, 2007, 8.2: 123-133.

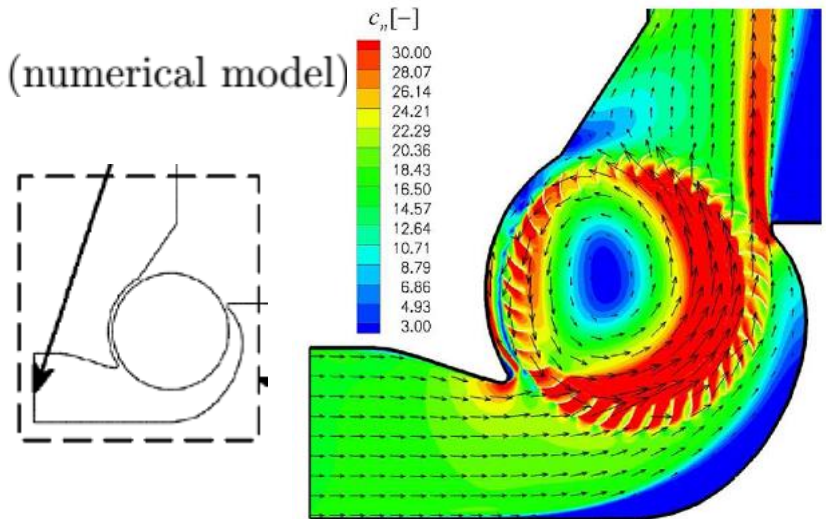


36 kanatlı



New geometry (numerical model)

- ÇART rüzgar türbini olarak kullanılabilir.
- İyileştirilmiş kabuk tasarımı ile başarımlar artırılmıştır.
- Akış yapılarının incelenmesi ile daha yüksek başarımlara erişilebilir.
- Deneysel çalışmalara ihtiyaç vardır.



Giriş –Çapraz akışlı rüzgar türbinleri

MANDIŞ, Ioana Corina; ROBESCU, Dan Niculae; BĂRGLĂZAN, Mircea. Capitalization of wind potential using a modified banki turbine. U.P.B. Sci. Bull., Series D, 2008, 70.4, 115-124.

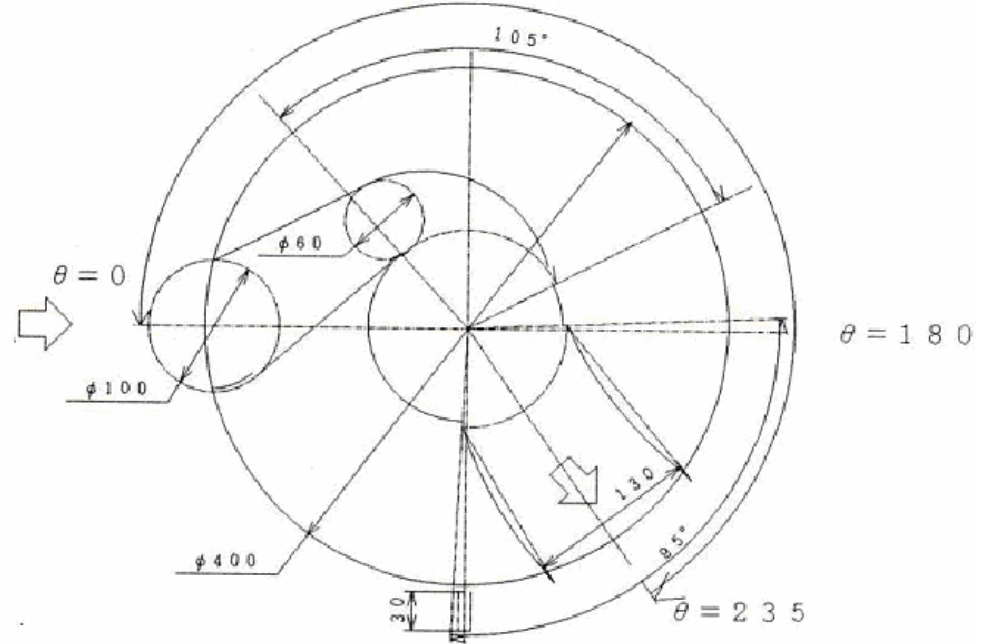
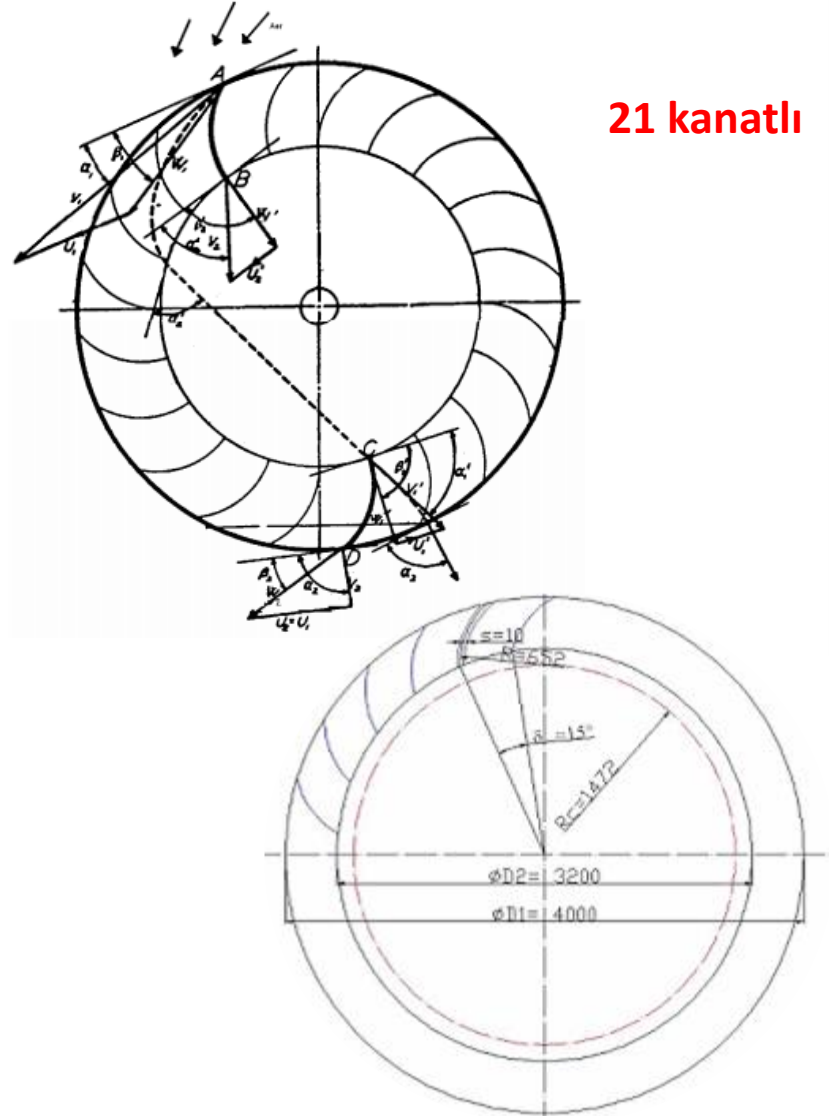


Fig. 5. The wind turbine nozzle

Banki türbini (Osberger türbini) uygun yönlendiriciler ve lüle tasarımlarıyla düşük rüzgar hızlarında elektrik üretebilen bir rüzgar türbini olarak kullanılabilir ???

Giriş –Çapraz akışlı rüzgar türbinleri

COLLEY, Gareth, et al. Effect of rotor blade position on Vertical Axis Wind Turbine performance. In: proceedings of the International Conference on Renewable Energies and Power Quality (ICREPQ'10) Granada, Spain. 2010.

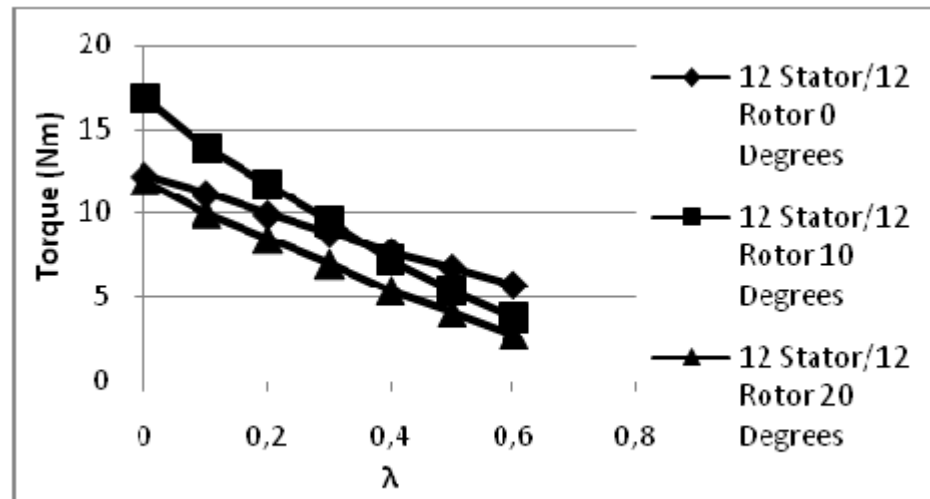
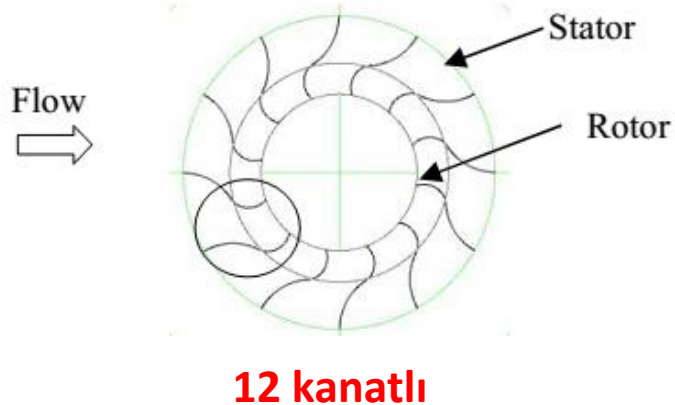


Figure 15 'Variation of torque output with respect to λ '

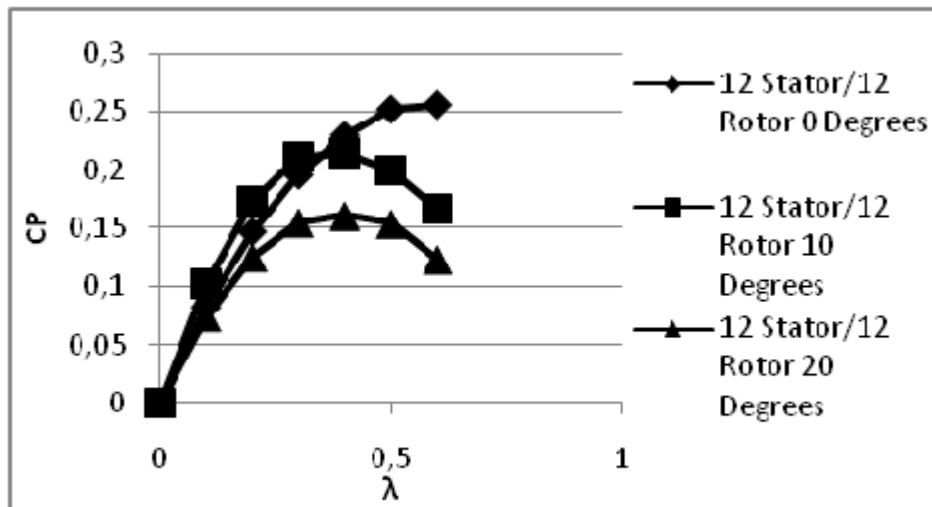


Figure 16 'Variation of power output with respect to λ '

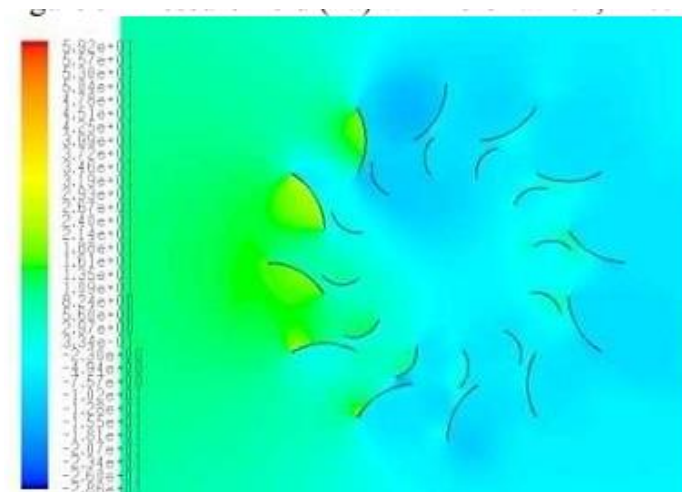
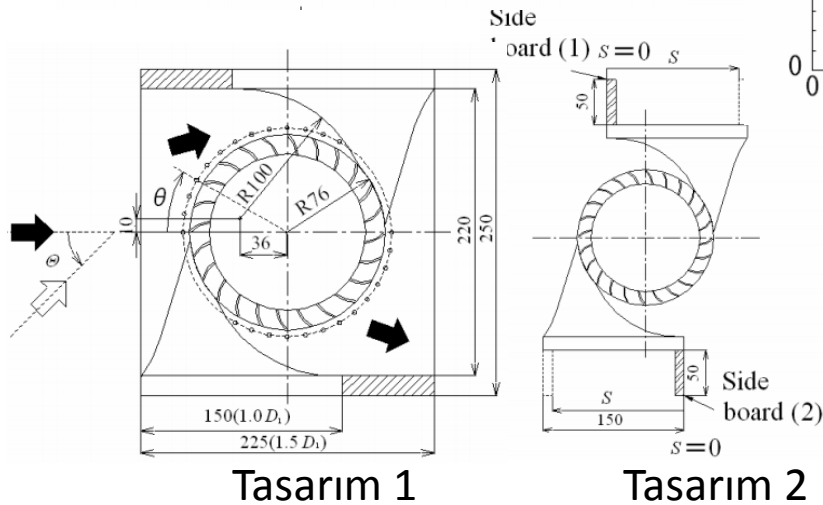
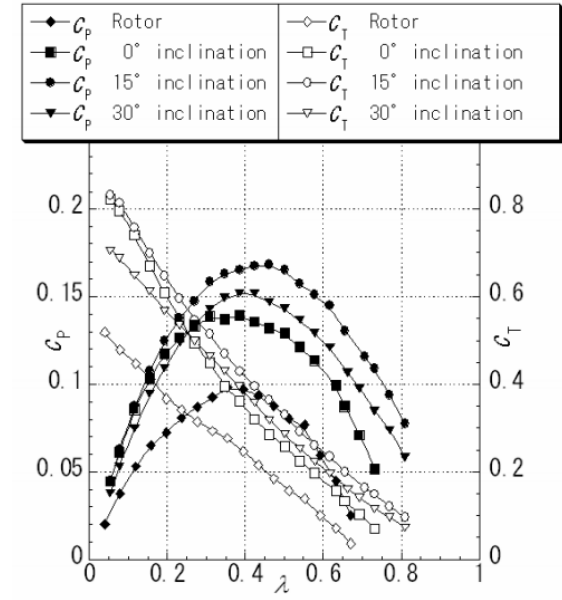
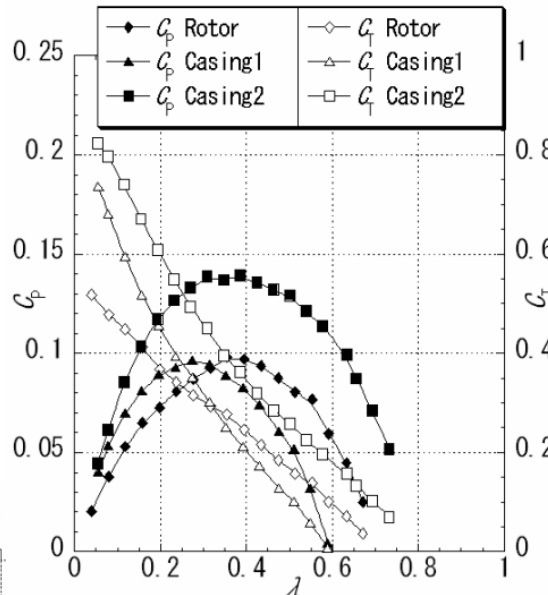
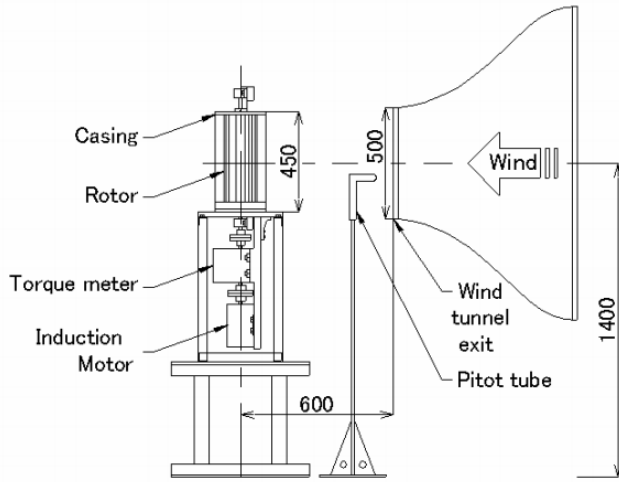


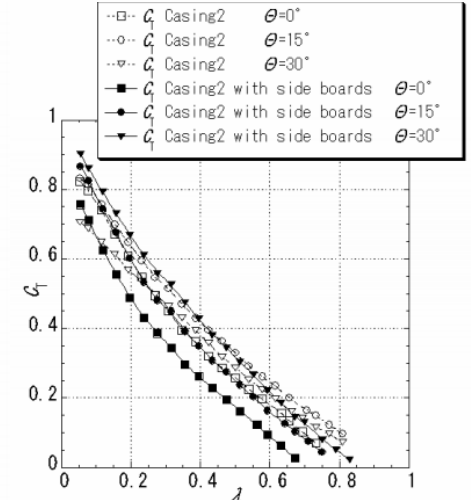
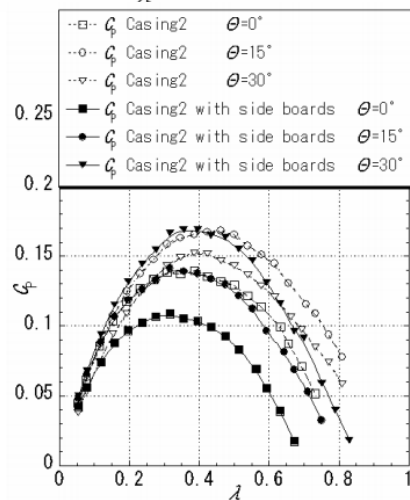
Figure 6 'Pressure field (Pa) with rotor at 20°, $\lambda=0.4$ '

Giriş –Çapraz akışlı rüzgar türbinleri

FUKUTOMI, Junichiro; SHIGEMITSU, Toru; DAITO, Hiroki. Study on performance and flow condition of a cross-flow wind turbine with a symmetrical casing. Journal of Fluids Engineering, 2011, 133.5: 051101.



24 kanatlı



(a) Power coefficient

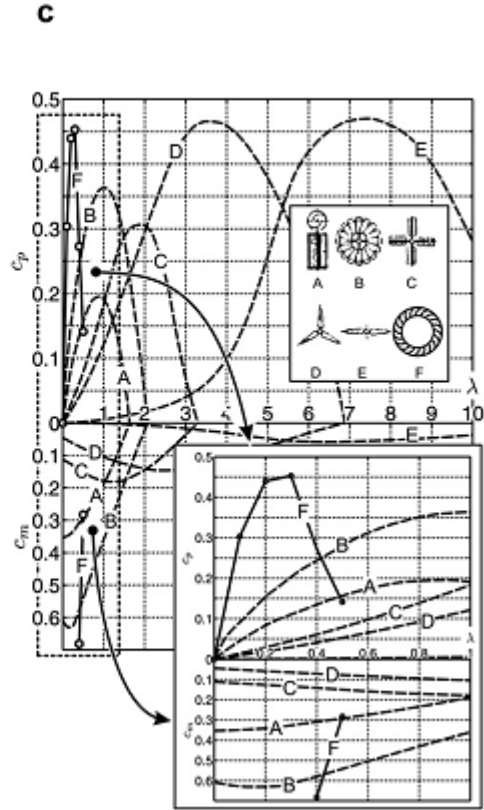
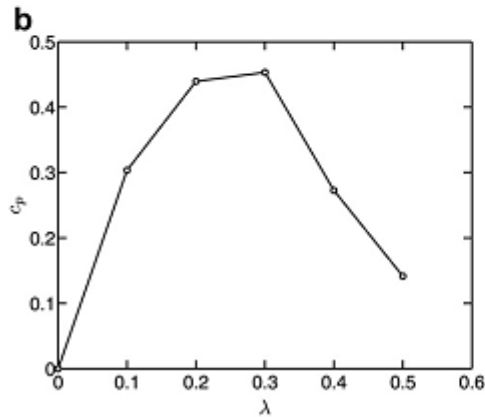
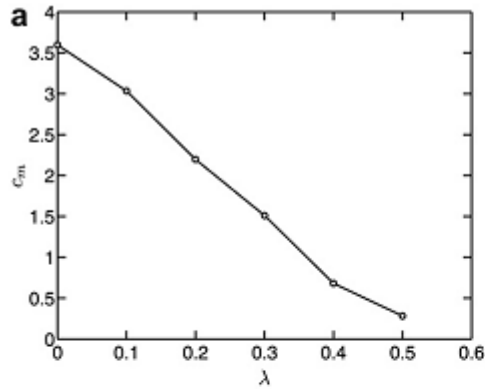
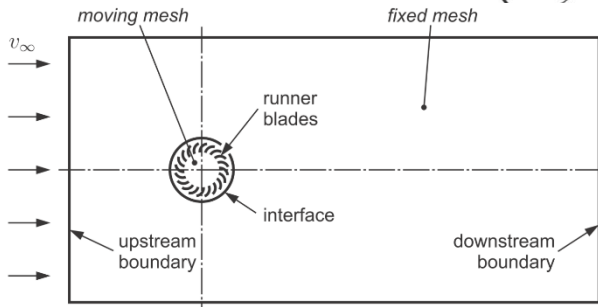
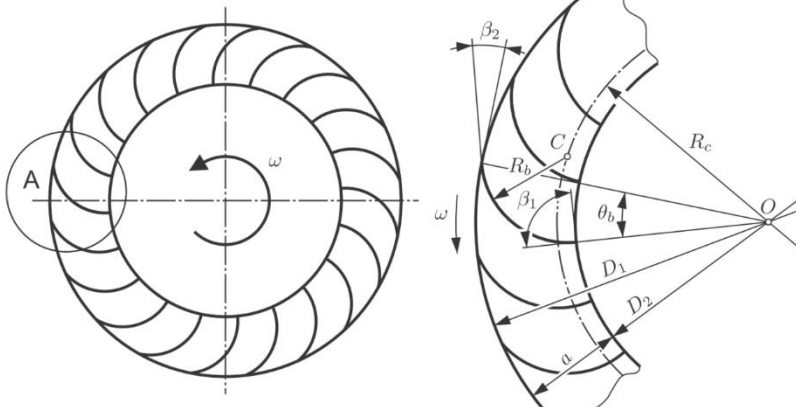
(b) Torque coefficient

Giriş –Çapraz akışlı rüzgar türbinleri

DRAGOMIRESCU, A. Performance assessment of a small wind turbine with crossflow runner by numerical simulations. *Renewable Energy*, 2011, 36.3: 957-965.

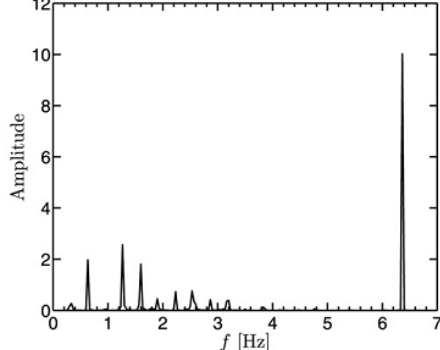
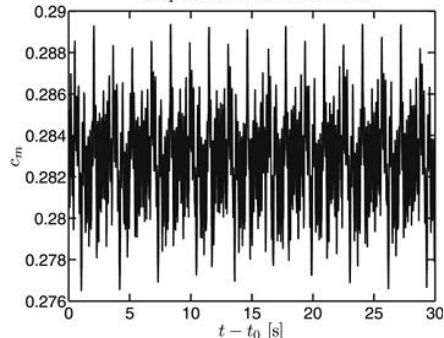
20 kanatlı

Detail A



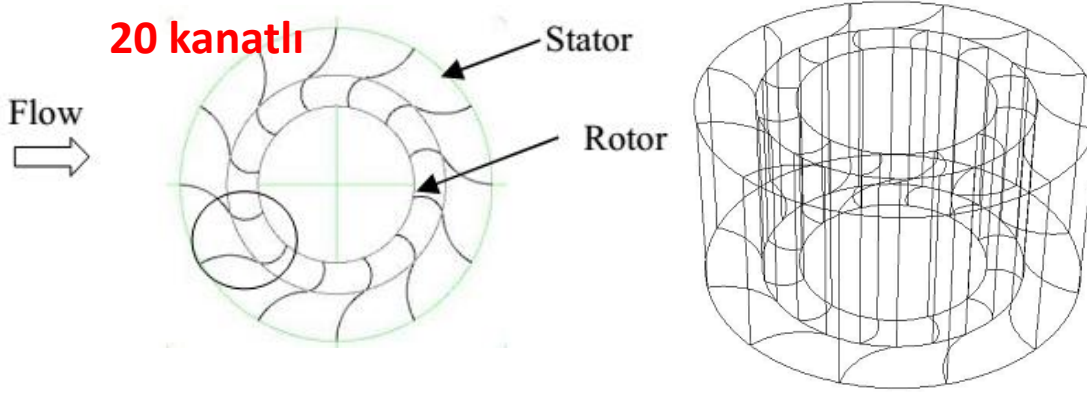
Torque coefficient for λ = 0.5

Frequency spectrum of c_m for λ = 0.5



Giriş –Çapraz akışlı rüzgar türbinleri

Colley, Gareth and Mishra, Rakesh (2011) Performance characteristics of a Vertical Axis Wind Turbine (VAWT) under transient conditions. In: Proceedings of the 24th International Congress on Condition Monitoring and Diagnostics Engineering Management. COMADEM, Stavanger, Norway.



2 ve 3 boyutlu analizler karşılaştırıldığında hesaplanan tork değerinde %2 lik bir fark olduğundan hesaplamalar 2 boyutlu model ile yapılmıştır.

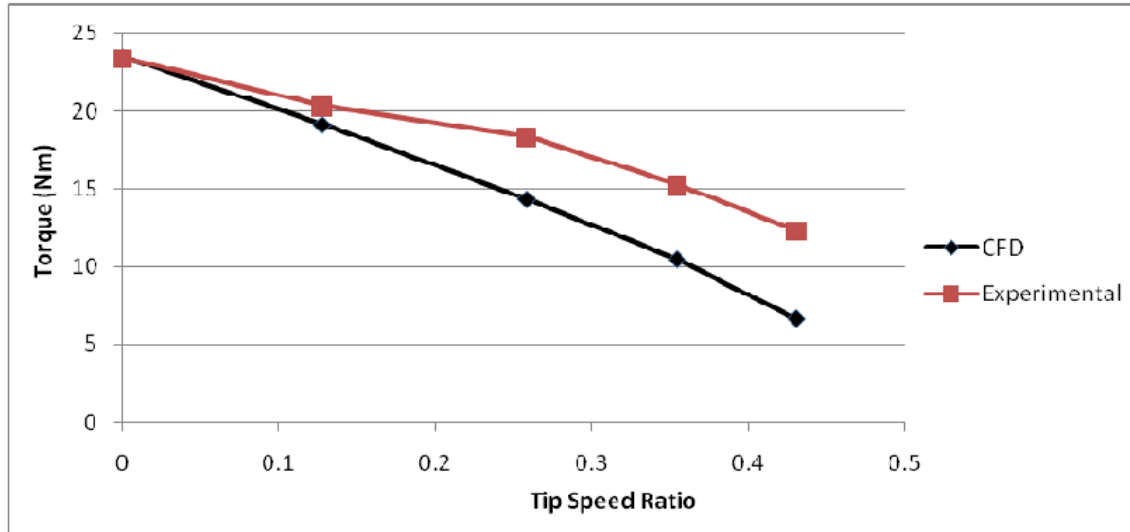
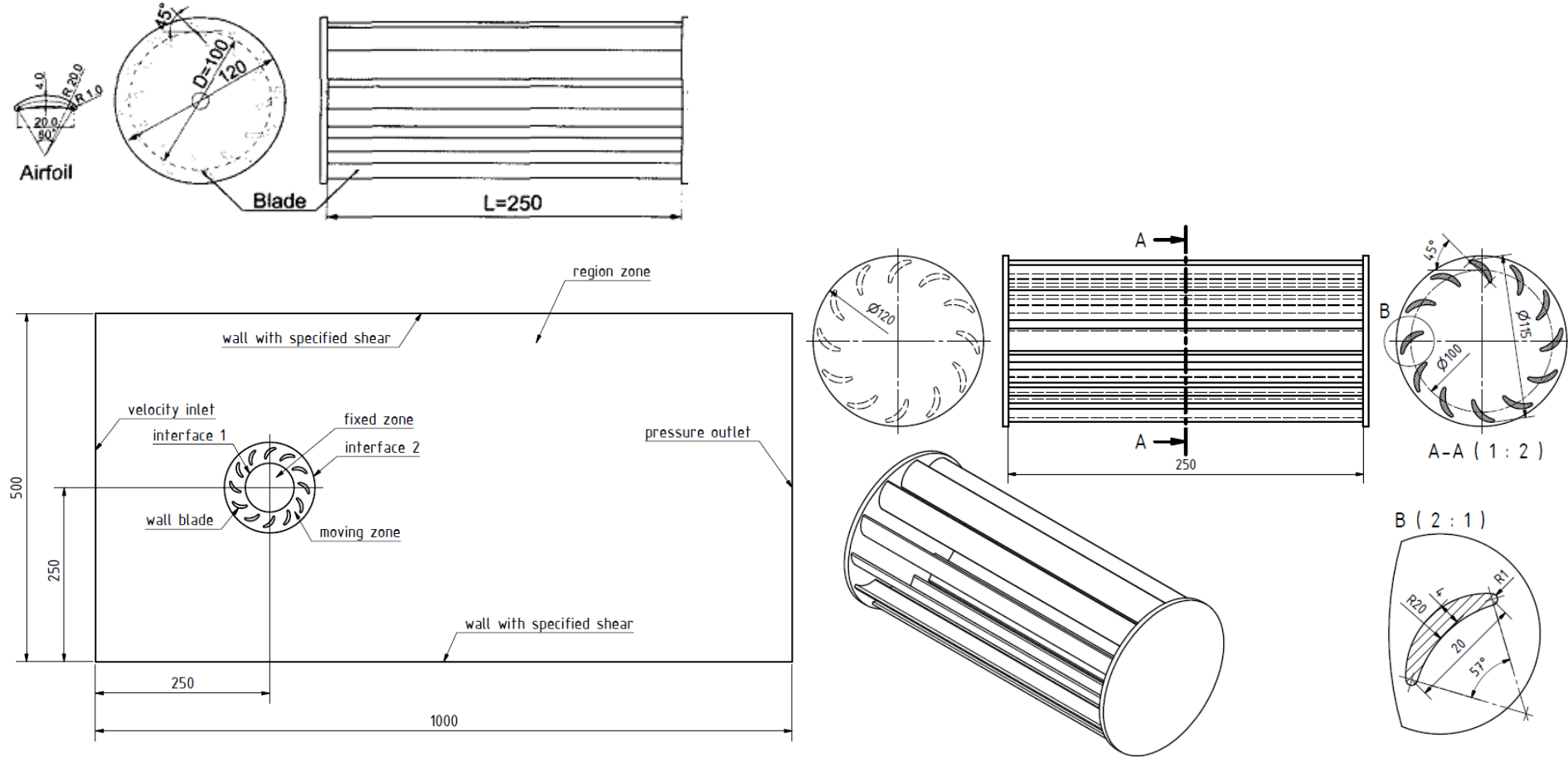


FIGURE 16. CFD wind turbine torque curve plotted with Tip Speed Ratio

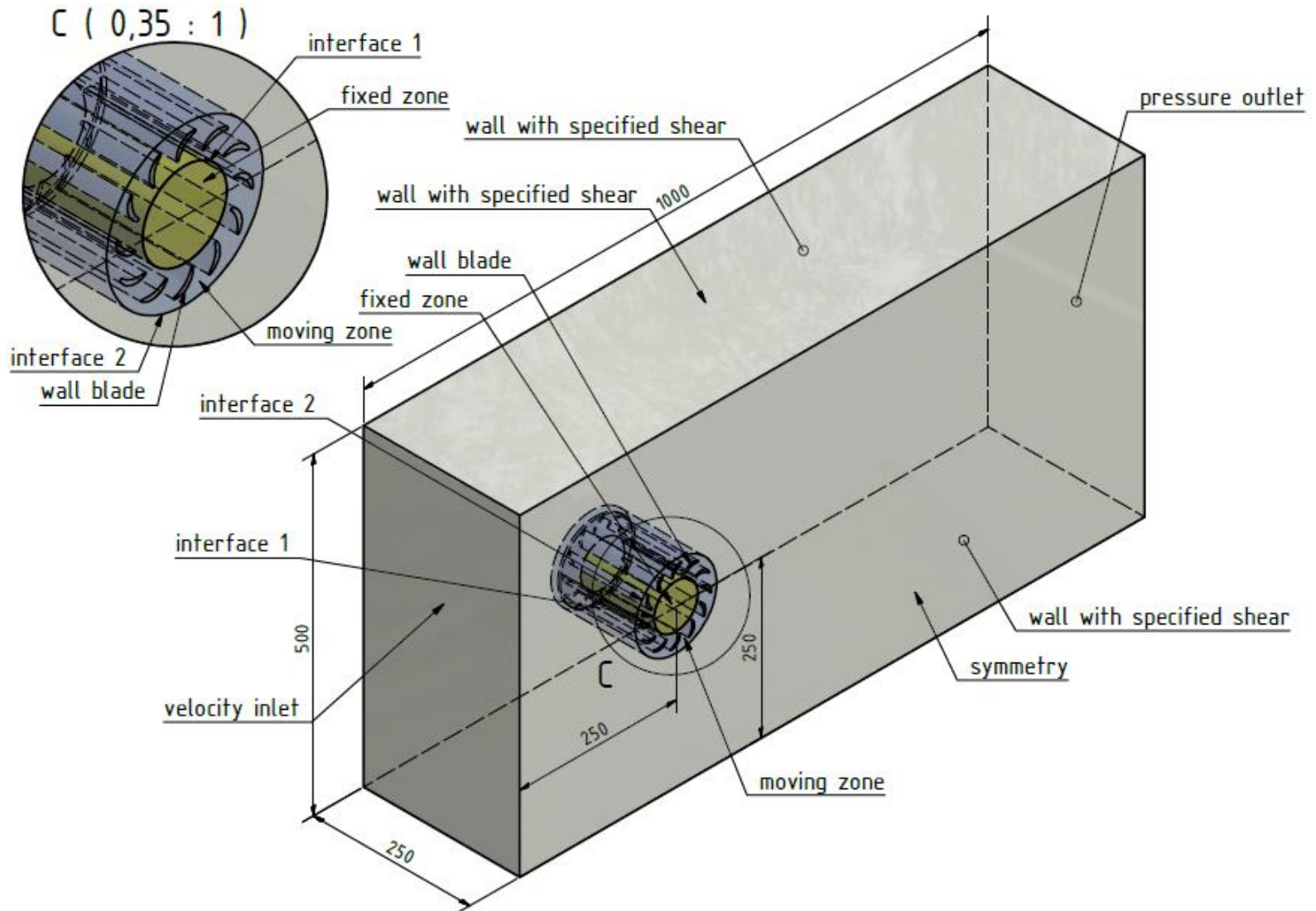
Sayısal Çalışma – Geometri ve sınır şartları

TANINO, Tadakazu; NAKAO, Shinichiro; UEBAYASHI, Genki. Improving ambient wind environments of a cross-flow wind turbine near a structure by using an Inlet Guide Structure and a Flow Deflector. Journal of Thermal Science, 2005, 14.3: 242-248.



Serbest rüzgar hızları $v=4$ m/s ve $v=8$ m/s olarak tanımlanmıştır.

Sayısal Çalışma – Geometri ve sınır şartları

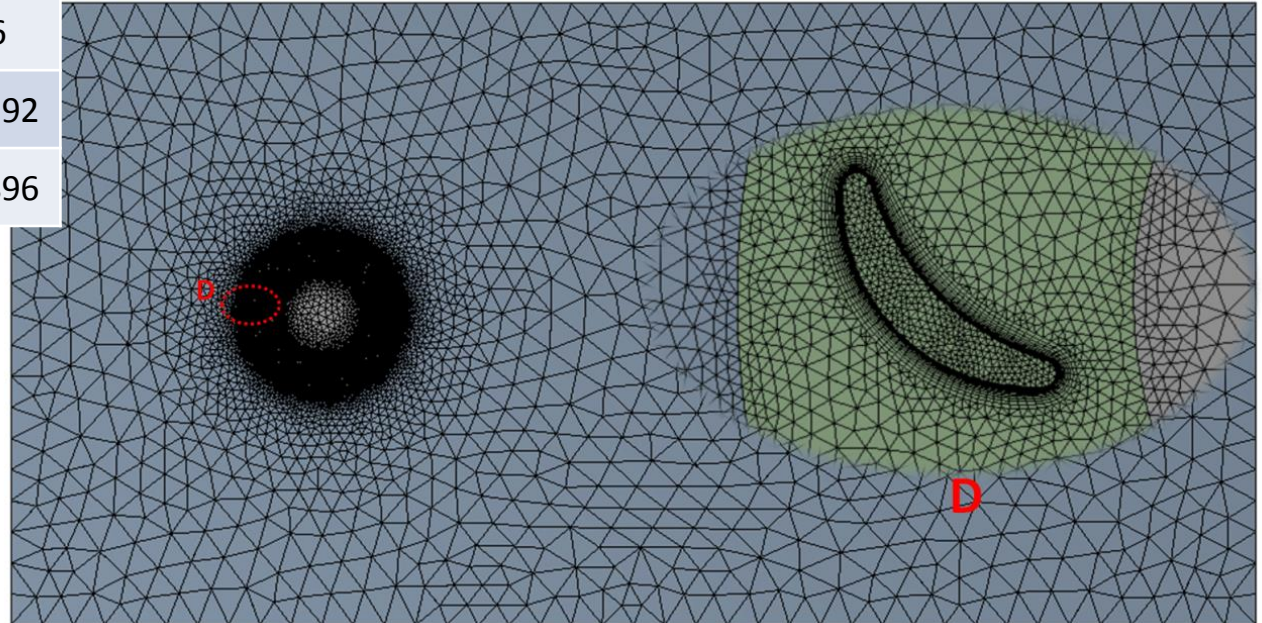
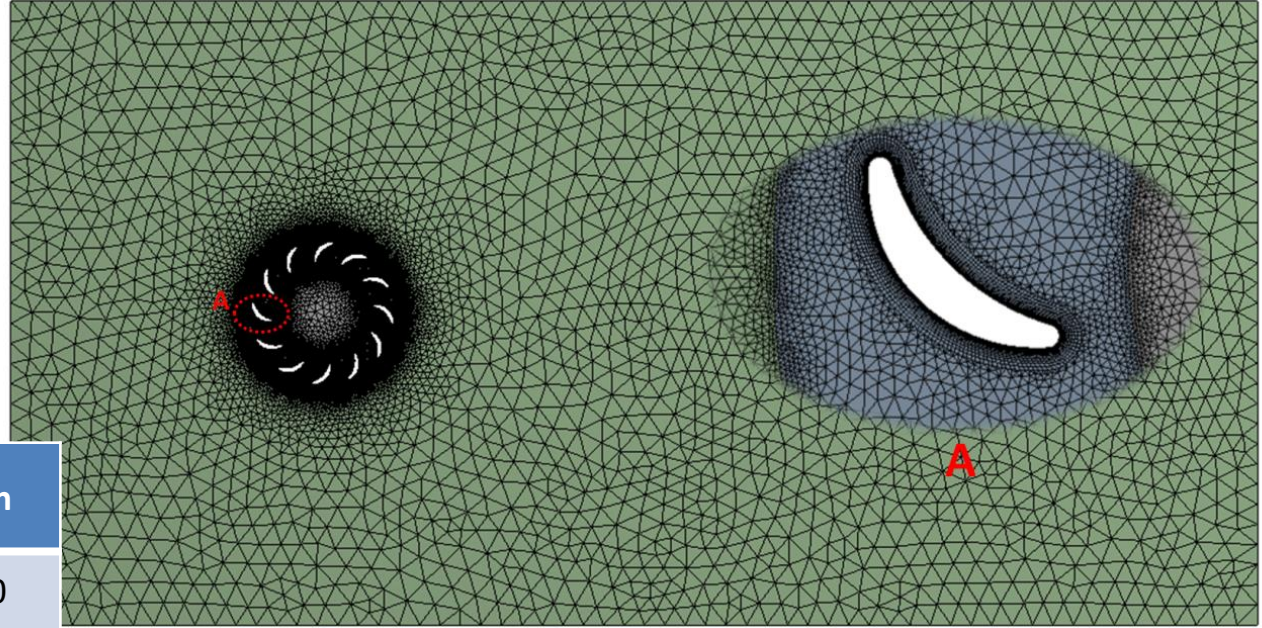


Sayısal Çalışma –Ağ yapı

y^+ değeri 1 hedeflenerek $v=4$ m/s ve $v=8$ m/s giriş hızları için rotor kanatları üzerinde sınır tabakadaki ilk hücre yüksekliği 0,049 mm ve 0,0245 mm olarak hesaplanmıştır.

Model	Hız m/s	Düğüm	Eleman
2B	4	57.365	77.630
	8	59.068	81.036
3B	4	10.504.579	29.132.992
	8	10.774.886	30.730.896

Hesaplanan ilk hücre yüksekleri için sayısal çalışmalara ait sınır tabakalar 15 katmandan meydana getirilmiştir.



Sayısal Çalışma –Kabuller

$v=4$ m/s ve $v=8$ m/s olarak tanımlanmıştır. $\lambda=0,1-0,2-0,3-0,4-0,5-0,6-0,7-0,8$ değerlerini sağlayacak şekilde;

$v=4$ m/s için dönel akışkan bölgeye ait açısal hızlar $w=0, 8, 16, 24, 32, 40, 48, 56, 64$ rad/s

$v=8$ m/s için açısal hızlar $w=0, 16, 32, 48, 64, 80, 96, 112, 128$ rad/s

olarak tanımlanmıştır.

$$C_m = \frac{M}{0,5 \cdot \rho \cdot V^2 \cdot R \cdot A} \quad C_p = \lambda \cdot C_m \quad \lambda = \frac{w \cdot R}{V}$$

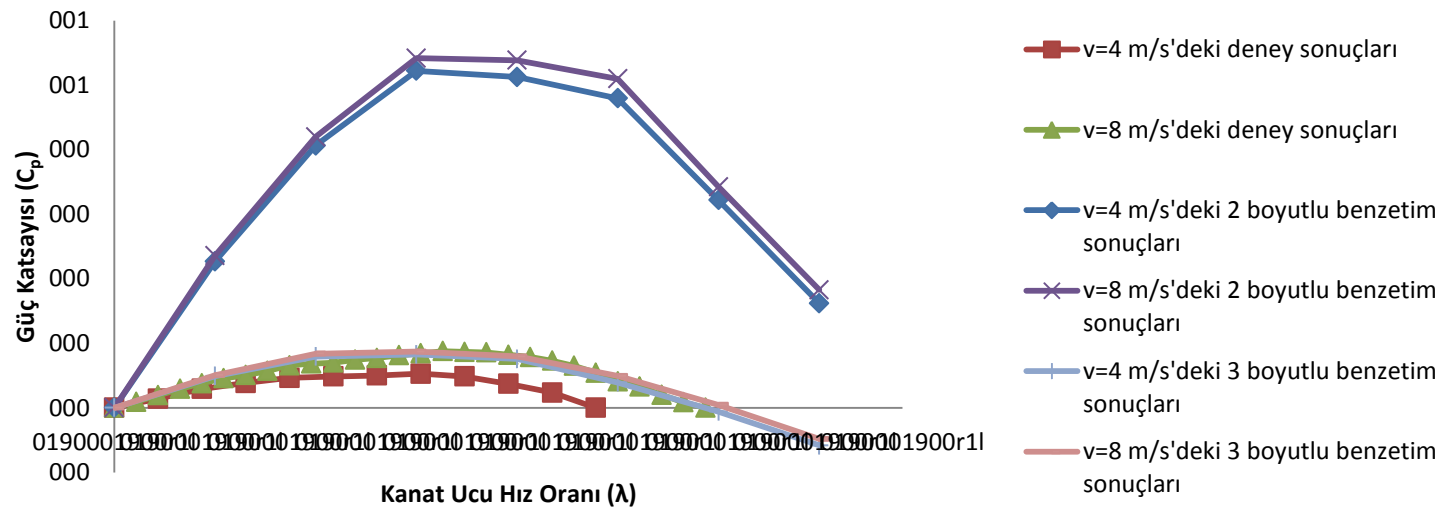
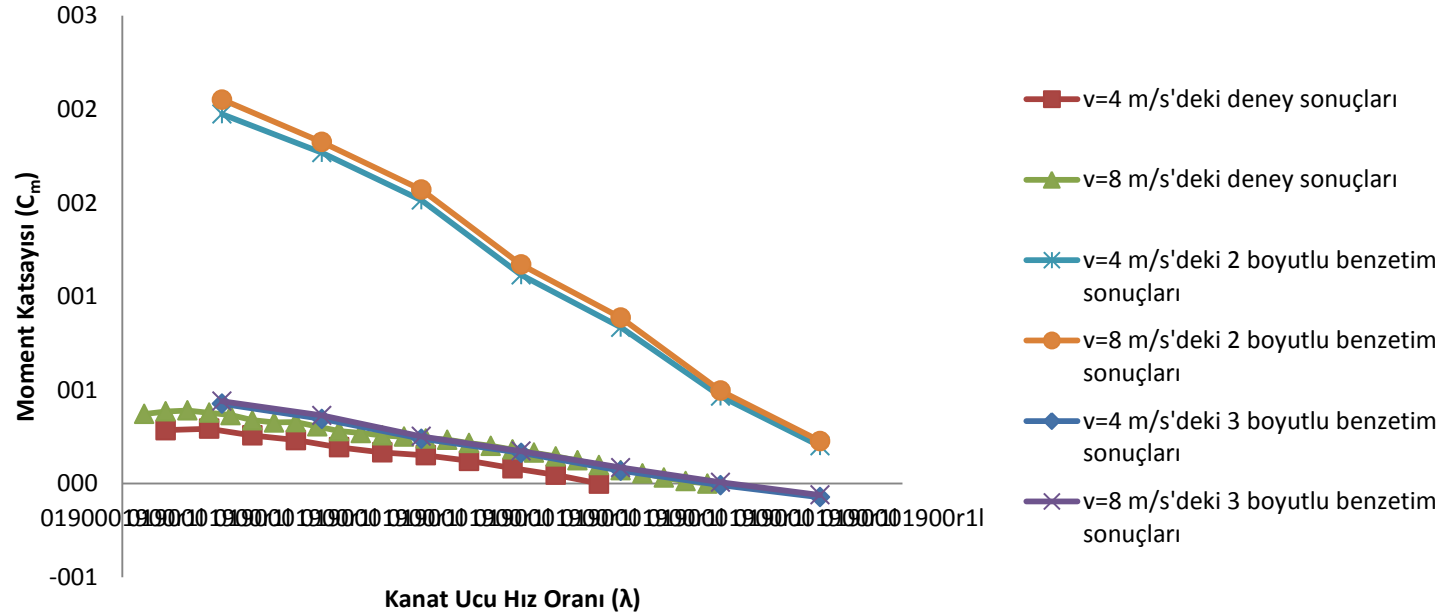
Bu formülde rüzgar tarafından türbine uygulanan moment (M), yapılan bilgisayar benzetimi sonucunda program tarafından hesaplanır.

Akışkan yoğunluğu (ρ), giriş hızı (V), kanatların dış uçlarına teğet geçen çemberin yarıçapı (R) ve rotorun rüzgar yönüne dik yönde taradığı alan (A) referans değerleri olarak programa tanıtılarak her bir iterasyon için moment katsayısı (C_m) hesaplanır. w; rotorun açısal hızıdır.

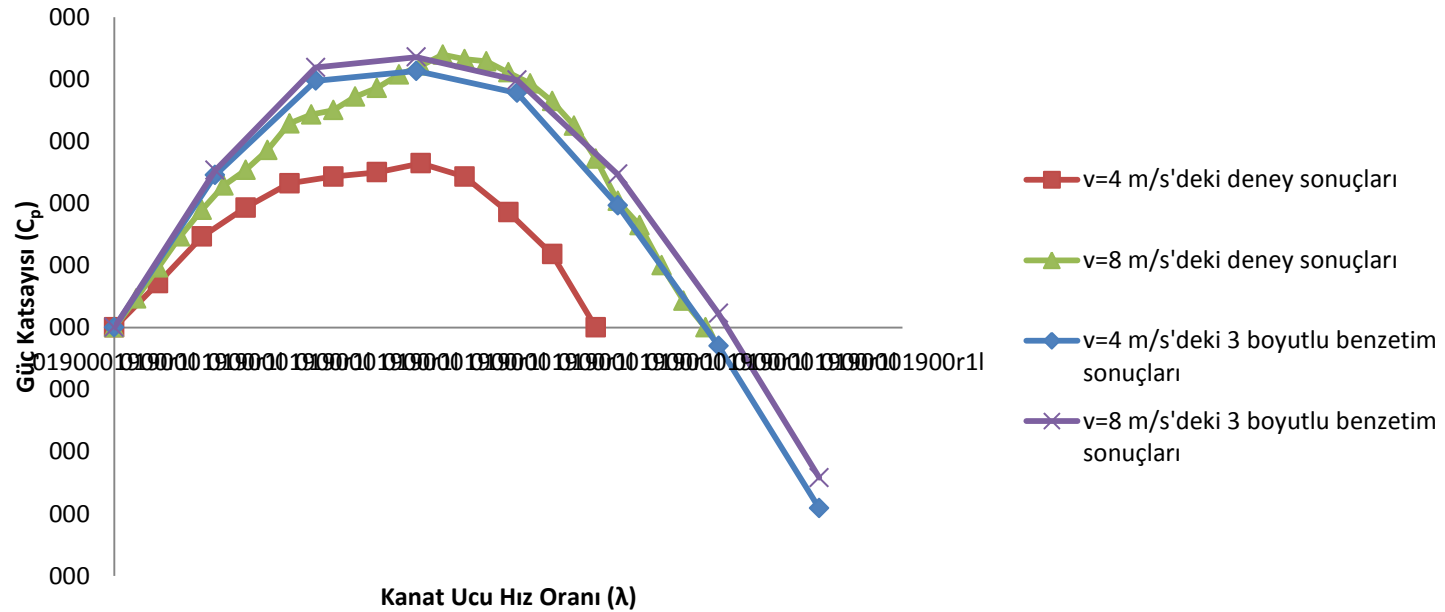
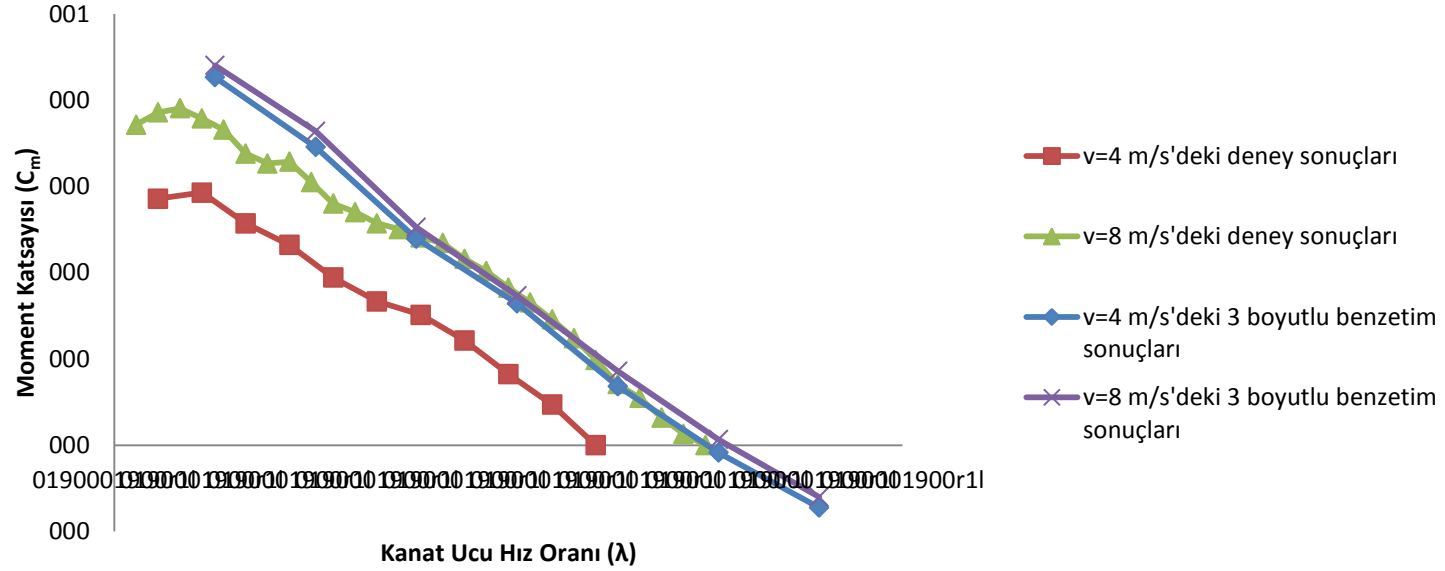
Havanın 15 C°’deki özellikleri kullanılmıştır.

Precision	Viscous Model	Pressure Velocity Coupling Scheme	Gradient	Pressure	Momentum	Turbulent Kinetic Energy	Turbulent Dissipation Rate
Double	SST k-omega	Coupled	Green Gauss Node Based	PRESTO	First Order Upwind	First Order Upwind	First Order Upwind

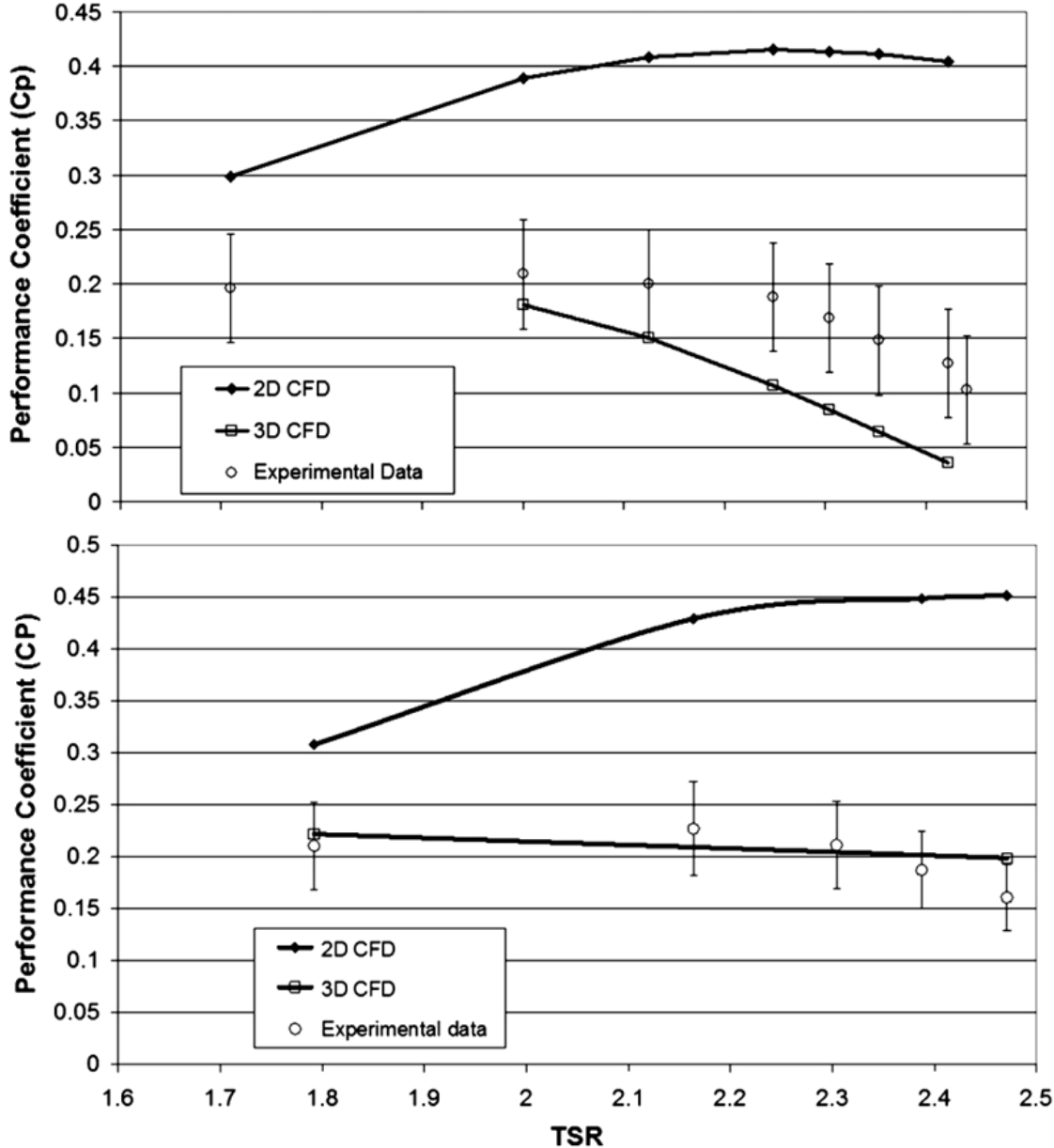
Bulgular ve Değerlendirme



Bulgular ve Değerlendirme



Bulgular ve Değerlendirme



Robert Howell, Ning Qin, Jonathan Edwards, Naveed Durrani, 2010, Wind tunnel and numerical study of a small vertical axis wind turbine, Renewable Energy, 35, 412-422

The predictions show that the presence of the over tip vortices in the 3D simulations is responsible for producing the large difference in efficiency compared to the 2D predictions.

Sonu

Bu alıřmada, tekil alıřma durumu incelenen bir ART'ın bařarımının belirlenmesi iin yapılan **iki boyutlu ve  boyutlu bilgisayar benzetimleri** sonucunda elde edilen **tork ve g katsayısı eđrileri** literatrdeki deney sonuları ile karřılařtırılarak ** boyutlu sayısal modellemenin nemi** ortaya koyulmuřtur.

Bu farkın, literatrdeki diđer trbinler iin yapılmıř benzer alıřmalarda da ngrldđ gibi, ART'ların oluřturduđu **karmařık akıř yapısından** kaynaklandıđı dřnlebilir.

Sayısal alıřmada yapılan **kabuller ve basitleřtirmeler** nedeniyle bu farklılık net olarak grlememiř de olabilir.

Ancak, **literatrde** farklılıđın kaynađı ile ilgili yapılan her iki aıklamayı da destekleyecek **yeterli alıřma yoktur**.

Bu nedenle incelemeler artırılmalı ve zellikle apraz Akıřlı Fan'lar iin yapılan alıřmalardan elde edilen sonular da gz nnde bulundurulurak geometrik parametrelerin ve akıř ile ilgili farklılıkların ART bařarımı zerindeki etkileri **sistemantik olarak hem sayısal hem de deneysel olarak incelenmelidir**.

 ve iki boyutlu modelleme sonuları arasındaki farklılık sadece ART'ların bilgisayar benzetimleri ile incelenmeleri iin deđil **tm dřey eksenli rzgar trbinleri konusunda yapılan alıřmalar iin yol gstericidir**.

**İLGİNİZ İÇİN
TEŞEKKÜRLER**

