

ACFR[®]

ALUMINUM CONDUCTOR FIBER REINFORCED

Introduction of Innovative Conductor



June, 2018 @ ACEF

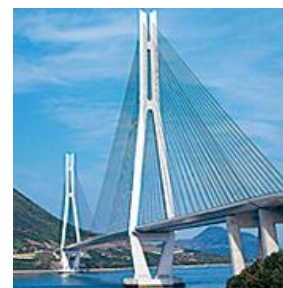
TOKYO ROPE INTERNATIONAL INC.



CFCC ACFR Division

Company Profile

- **Established** : 1887
- **Number of Employees** : 1,800
- **Sales** : US\$ 650 million
- **Products** :
 - Steel Wire Rope, Synthetic Fiber Rope, Carbon Fiber Cable,
 - Steel Cable for bridges
 - Steel Cord for tire reinforcement, Sawing Wire
 - Engineered Products for road safety devices, environment protection
 - Steel Wire Products for industrial and machinery applications
 - Die, Tool for wire products and forging

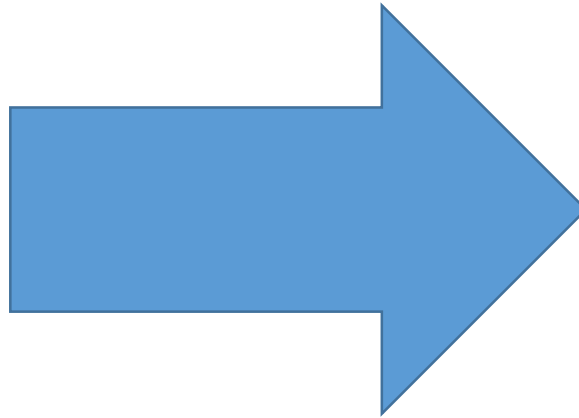


Company Profile

TOKYO ROPE'S STRENGTH



Stranding Specialist



**Globally the first company
to strand the carbon
composite material**



Overhead Conductor Market

Current

Conventional type conductor cable:

ACSR

Awaiting Solutions:

- Heavy steel core
- Large thermal expansion
- Corrosion



Challenge

Marketing needs...

- Huge Electric Demand
- Environmental Concern (CO₂)
- Sag Violations
- Right of Way issue
- Construction cost & period



Solution

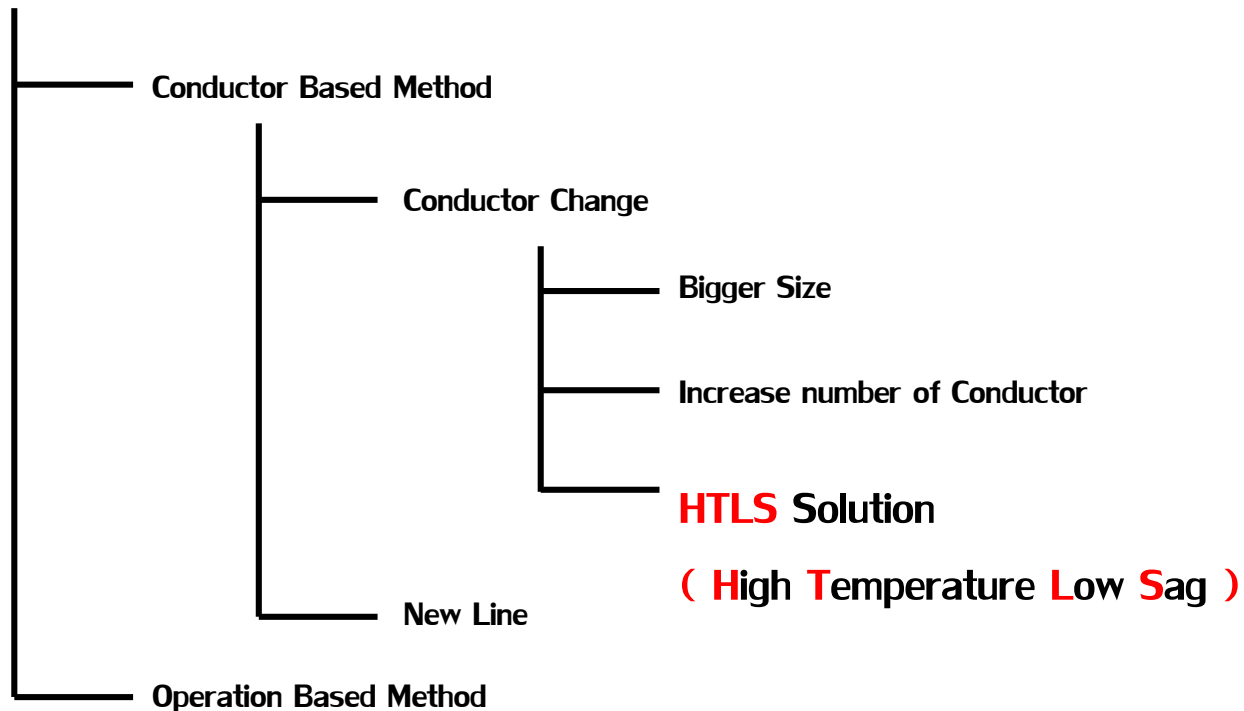
Next generation conductor cable:

ACFR

- Low transmission loss
- High transmission capacity
- Low sag
- Longevity
- Easy handling

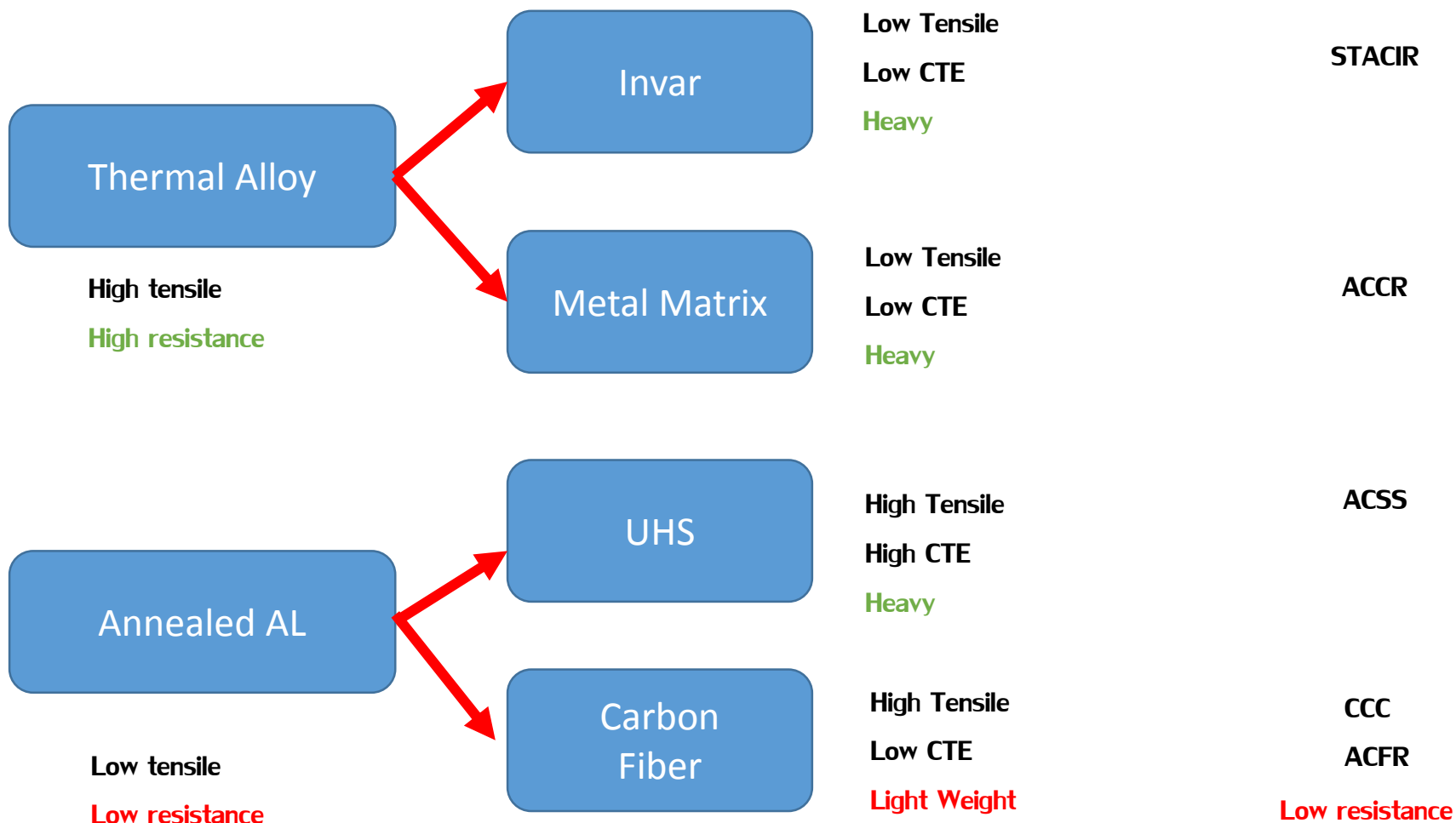
Transmission Capacity Increasing Method

1, Ampacity Based Solution



2, Voltage Based Solution

HTLS Technology



Carbon Fiber Conductor is the best option for low loss

What is

ACFR

<Conventional overhead conductor cable: **ACSR**>

“**A**luminum **C**onductor **S**teel **R**einforced”

- Steel wire core → Heavy weight / Large thermal expansion
- Round shaped aluminum wire → Small cross sectional area

VS.

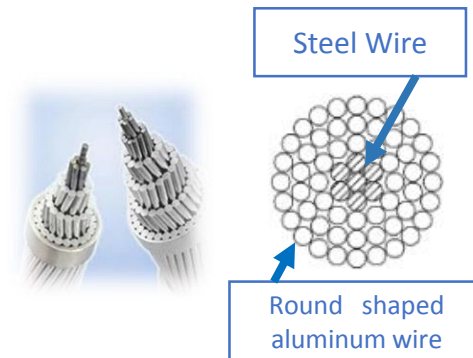
<High performance conductor cable:

>

ACFR

“**A**luminum **C**onductor **F**iber **R**einforced”

- **CFCC** core → Light weight / Small thermal expansion
- Trapezoidal aluminum wire → Large cross sectional area



Aluminum for



Application

Low Resistance

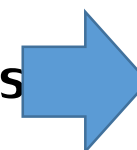
Better sag

Easy Installation and Handling like ACS

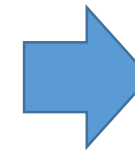
Conductive Outer Layer



1350-O temper



AT-1 (TAL)



Market

Indonesia

China

Malaysia

Japan

Taiwan

Brazil

		Hard-drawn A1350-H19	Annealed A1350-O	Thermal- resistant TAI (AT1)
Conductivity	[%IACS]	61.2	63.0	60.0
	[%]	100	103	98
Maximum operating temperature	[°C]	90	250	150
Tensile Strength	[MPa]	162-172	55-96	165-186

* See Annex 2-1 for examples of ACFR specification.

Core for



Core Material – Different Technology

Conductor		ACSR	ACSS	STAC R	Solid CCC	ACFR
Strength	Mpa	1,300	1,381	1,275	2,158	2,158
Modulus	Gpa	200	200	152	117	130
CTE	$\times 10^{-6}/^{\circ}\text{C}$	11.5	11.5	3.7	1.6	1.0
Weight	kg/km	1.3	1.3	1.3	1.1	0.9

High Strength
Low expansion
Lesser Weight

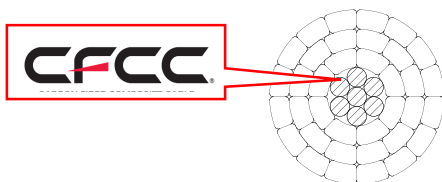
Core for

ACFR

CFCC

“Carbon Fiber Composite Cable”

Stranded CFRP developed by **TOKYO ROPE**



- **Light Weight** : 1/5 of Steel
- **Low Linear Expansion** : About 1/10 of Steel
- **High Strength** : 30-40% more than Steel for conductor core
- **Non-magnetic** : No Iron Loss
- **High Flexibility** : High bending angle, smaller diameter of stringing sheave
- **High Corrosion resistance** : Against acid, alkali, water and UV
- **High Tensile Fatigue** : Able to withstand wind vibration
- **Low Creep Elongation** : Similar to Steel
- **High Modulus** : Equal to Steel

Core for

ACFR

CFCC

TRI
TOKYO ROPE INTERNATIONAL

Source : Boeing Japan HP



- Ingredient of **CFCC** “Torayca®”, Carbon fiber made by TORAY
- Torayca® is applied to state of the art aircraft such as Boeing 787



The Wing of Boeing 787

Black bones are made of Torayca®

Source : Bloomberg ©

Core for



~ History of CFCC and ACFR ~

- 1980s Started development of **CFCC**
- 1986 Supplied for PC Bridge Project in Japan
- 2001 Supplied for PC Bridge project in Michigan/USA
- 2002 Supplied for **ACFR** project in Japan
- 2011 Estimated Gamagori **CFCC** Plant in Japan
(First full-scale integrated **CFCC** factory)
- 2012 Supplied for **ACFR** project in China
- 2015 Supplied for **ACFR** project in Indonesia
- 2016 Estimated Michigan **CFCC** Plant in USA
(First overseas **CFCC** production facility)

Gamagori Plant
(Japan)Michigan Plant
(U.S.A.)

Case Study 400 KV – CTU & STU

Description	ACSR Moose	Need
Voltage (kV)	400	400
Tension 32 deg. Full wind (122 Kg/sq.m)	6740	6740
Tension @ 5 deg. 36 % of Full wind (44 Kg/Sq.m)	4712	4712
Sag at 85 deg.c – 400 Span	13.26	13.26
Ampacity @ 85 deg.c	800	1500

**Double
Ampacity than
the existing
capacity
Without
Violating the
existing
Ground
Clearance**

Case Study 400 KV – Different Technology

Description	ACSR Moose	Requirement	ACSS	STACIR	CCC	ACFR
Diameter (mm)	31.77	≤ 31.77	30.19	28.95	31.77	31.77
Weight (Kg/Km)	2004	≤ 2004	1993	2001	1988	1968
Voltage (kV)	400	400	400	400	400	400
Tension 32 deg. Full wind (122 Kg/sq.m)(Kg)	6740	6740	6648	6566	6569	6540
Tension @ 5 deg 36 % of Full wind (44 Kg/Sq.m) (Kg)	4712	4712	4712	4712	4712	4712
Sag at below Amps (Meters)	13.26	13.26	13.97	13.26	12.39	12.36
Ampacity & OT (Amps) & (Deg.c)	800 (85)	1500	1500 (182)	1500 (175)	1500 (133)	1500 (131)

ACFR Lesser Sag and Low Operating Temperature than any other technology

Case Study 220 KV – South India STU

Description	Existing ACSR Zebra Conductor	Need of STU
Voltage (Kv)	220	220
Ampacity @ 75 deg.c	550	1200
Tension 32 deg. Full wind (83 Kg/sq.m)	4981	4981
Sag at 75 deg.c – 350 Span	9.24	9.24

More than Double Ampacity than the existing capacity Without Violating the existing Ground Clearance

Case Study 220 KV – Different Technology

Description	ACSR Zebra	Requirement	STACIR	CCC	ACFR
Diameter (mm)	28.62	≤ 28.62	25.5	28.14	28.62
Weight (Kg/Km)	1621	≤ 1621	1600	1565	1590
Voltage (kV)	220	220	220	220	220
Tension 32 deg. Full wind (83 Kg/sq.m) (Kg)	4981	6489	4981	4981	4981
Sag at below Amps (Meters) – 350 span	9.24	9.236	9.236	8.43	8.40
Ampacity & OT (Amps) & (Deg.c)	550 (75)	1200	1100 (138)	1200 (122.5)	1200 (118.4)

ACFR Lesser Sag and Low Operating Temperature than any other technology

Case Study 132 KV – North India STU

Description	Existing ACSR Panther Conductor	Need of STU
Voltage (Kv)	132	132
Ampacity @ 75 deg.c	379	1000
Tension 32 deg. Full wind (45 Kg/sq.m)	2840	2840
Sag at 75 deg.c – 365 Span	8.83	8.83

More than Double Ampacity than the existing capacity Without Violating the existing Ground Clearance

Case Study 132 KV – Different Technology

Description	ACSR Panther	Need	ACSS	STACIR	CCC	ACFR
Diameter (mm)	21	≤ 21	19.66	19.6	20.5	20.75
Weight (Kg/Km)	974	≤ 974	968	850	835	819
Voltage (kV)	132	132	132	132	132	132
Tension 32 deg. Full wind (45 Kg/sq.m) (Kg)	2840	2840	2840	2712	2724	2840
Sag at below Amps (Meters) – 365 Span	8.83	8.83	10.65	11.7	7.81	7.79
Ampacity & OT (Amps) & (Deg.c)	378 (75)	1000	1000 (210)	1000 (250)	1000 (166.6)	1000 (163.8)

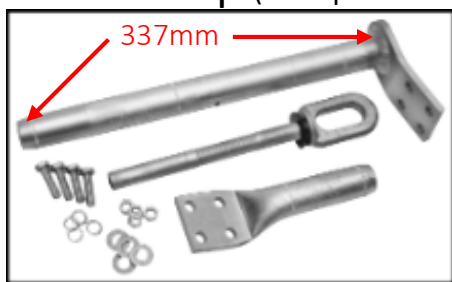
ACFR Lesser Sag and Low Operating Temperature than any other technology

Tension Hardware

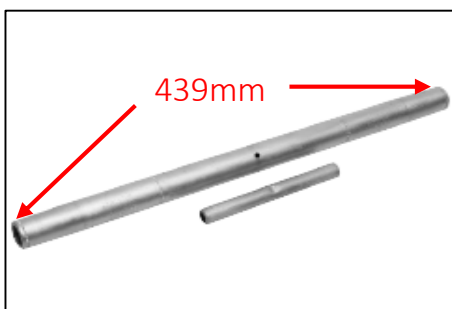
✓ Similar design and installation equipment to ACSR's.

ACSR

Dead End Clamp (example - Linnet size)



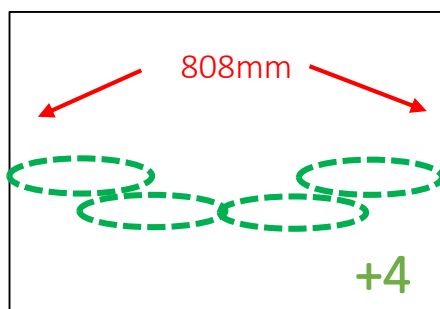
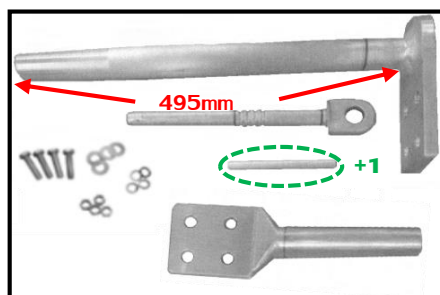
Mid Span Joint (example - Linnet size)



Equipment

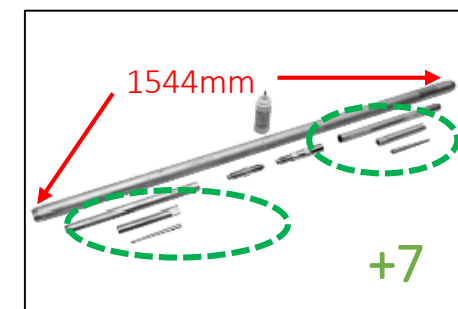
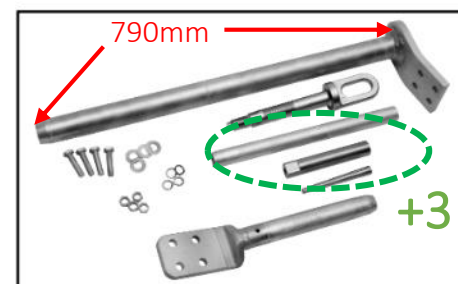
Compression Machine
Die x 2 set

ACFR



Compression Machine
Die x 2 set

CCC



Compression Machine
Die x 1 set
Torque Wrench for Collet
Mesh Sanding Paper

Installation of Hardware

✓ Easy installation of fitting process.



Dead end clamp for ACFR

Finish time is
5 minutes 35 seconds



Dead end clamp for ACSR

Finish time is
5 minutes 20 seconds

☆The video is playing by 4 times speed.

Key Stringing Criteria Comparison

✓ **Similar installation requirements to ACSR's.**

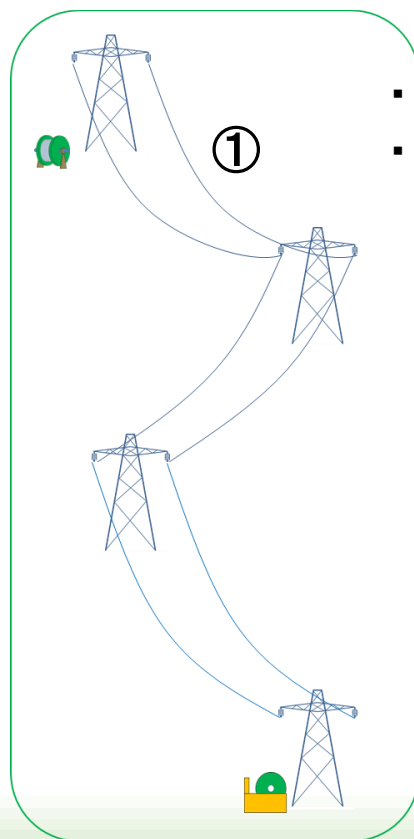
Conductor Type	ACFR		ACCC	TACSR	ACSS	ACCR
Aluminum	Annealed (1350-O)	Thermal Resistant (TA1)	Annealed (1350-O)	Thermal Resistant (TA1)	Annealed (1350-O)	Thermal Resistant (TA1)
Bull Wheels	40 x diameter		40 x diameter	40 x diameter	40 x diameter	1828mm Minimum
Sheaves Wheels	20 x diameter		25-35 x diameter	20 x diameter	20 x diameter	711mm Minimum
Grips (Pulling)	Kellums		Kellums	Kellums	Kellums	Special Grip
Grips (Sagging)	Chicago		Chicago	Chicago	Pocketbooks Chicago	
Recommended Pulling Angles	45 degrees	60 degrees	30 degrees	60 degrees	45 degrees	40 degrees
Dead End Installation Time	15 minutes		30 minutes	15 minutes	15 minutes	15 minutes
Mid Span Joint Installation Time	30 minutes		60 minutes	30 minutes	30 minutes	30 minutes

✓ In general, the conductors with carbon fiber core shall be handled with care (no drag/scratch, no over twist, no over bend) during installation work. Initial on-site training is available.

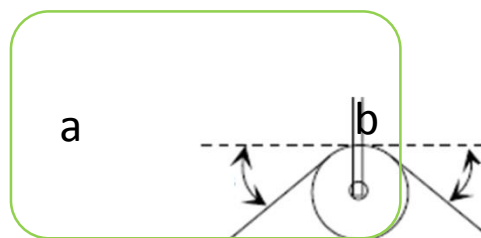
Bending Angle (Flexibility)

- ✓ Less numbers of stringing works.
- ✓ Smaller diameter of sheaves.

ACFR : One (1) stringing work



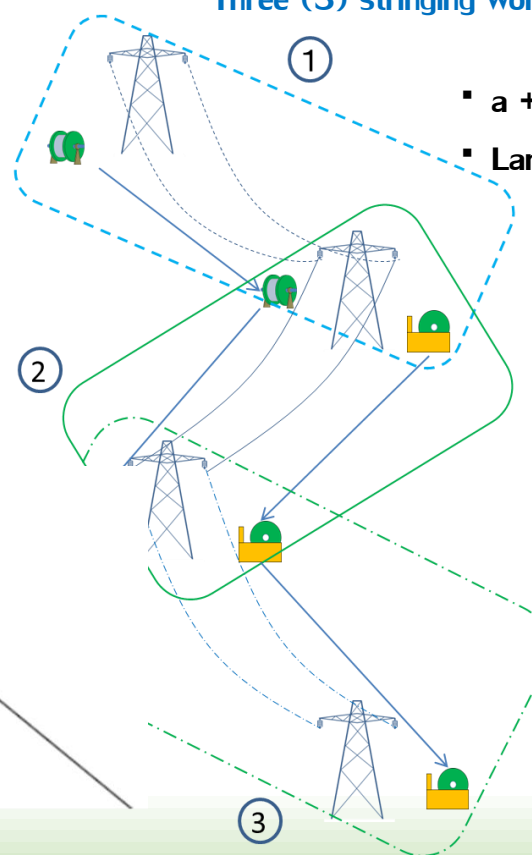
- $a + b < 45^\circ \sim 60^\circ$
- Smaller sheaves



* Conceptual image

CCC :

Three (3) stringing works



- $a + b < 30^\circ$
- Larger sheaves

Certification and Testing

Standards



IEEE



Design Tests

- UTS of Conductor and Core
- Stress Strain Conductor and Core
- Electrical Resistance test
- Creep Test
- Thermal Expansion
- Tg Test
- Flexural Strength
- Elongation

Installation Tests

- Sheave Test
- Bending Test
- Torsion Test
- Radial Crush Test
- Gripping Force

In-service/Operation Performance Tests

- Sag and Tension
- Corrosion
- Heat Exposure test for 52 weeks
- Heat Stress Test
- Temperature Cycle
- Strand Brittle Fracture test
- Fatigue Test
- High Temperature Creep
- UV Aging Test
- Fire retardant test



TAG CORPORATION®



TOKYO ROPE MFG. CO., LTD.

Certification



KOBELCO RESEARCH INSTITUTE, INC

Supply Record of



Year	2002	2003	2012	2013	2015	2016
Size	160/40	160/40	315/35	320/40	315/40	315/40
Voltage	66kV	66kV	110kV	220kV	150kV	150kV
Location	Miyagi Japan	Niigata Japan	Guangdong China	Hainan China	Kalimantan Indonesia	Medan Indonesia
Owner	Tohoku Electric Power Co., Inc.	Tohoku Electric Power Co., Inc.	China Southern Power Grid	China Southern Power Grid	PLN	PLN



The very first carbon core conductor commissioned in the world.
The line is up and running ever since.

Project Profile : Lower Sagging

Project Overview

Customer	Tohoku Electric Power Co
Project	Kashimadai Line / Sekiya Line
Location	Miyagi, Niigata / Japan
Year Installed	2002
Conductor Length	3 KM / 2KM
Voltage	66 kV

Solution

ACFR 160/40 (Round Shaped Hard Drawn AL)

Result

20% capacity increase while maintaining clearances

Used existing towers without modification

Maintained existing right of way

Saved time for installation



The oldest transmission line using carbon core in the world

Operation Certification

Japanese

東京製綱株式会社

平成26年 7月11日

東北電力株式会社

カーボンファイバ心アルミより線 (ACFR:Aluminium Conductor Carbon Fiber Reinforced) の使用実績証明書

東北電力株式会社は、下記実績表に示す、カーボンファイバ心アルミより線が運用開始時より現在まで、問題なく運転していることを、ここに証明いたします。

表1 ACFRの使用実績

実績№ 支店名	表1 ACSRの使用実績		2	
線路名・使用区間 使用こう長 所在地 電線種別 架線時期 腐食環境※1 採用理由 許容電流	宮城支店		新潟支店	
	66kV 鹿島台線 №5～№9		66kV 関屋線 №3～№5	
	1,063m		462m	
	宮城県石巻市広瀬地内		新潟県新潟市西区小新地内	
	ACFR160mm ²		ACFR160mm ²	
	2002年12月		2003年10月	
	0.25mg/cm ²		0.50mg/cm ²	
	地上高対策		地上高対策	
	90℃：454A、120℃：600A			
採用効果※2 [ACSRとACFRの地度差]	電線温度 90℃ [単位：m]			
	径間長	ACSR(A)	ACFR(B)	(A)～(B)
	S=200	5.08	3.70	1.38
	S=250	7.27	5.66	1.61
	S=300	9.88	8.04	1.84
	S=350	12.91	10.83	2.08
	S=400	16.38	14.03	2.35
	電線温度 120℃ [単位：m]			
	径間長	ACSR(A)	ACFR(B)	(A)～(B)
	S=200	5.76	3.73	2.03
	S=250	8.03	5.70	2.33
	S=300	10.70	8.09	2.61
	S=350	13.78	10.88	2.90
	S=400	17.29	14.09	3.20
電線・架線状態	架線時期の状態を保ったまま、 変状は見られない。 問題なく供用中。		架線時期の状態を保ったまま、 変状は見られない。 問題なく供用中。	

※1 腐食環境は想定塩分付着密度

※2 計算条件 最大使用張力 25.5kN

[高温季]風圧 980Pa, 15℃ [低温季]風圧 490Pa, -15℃, 6mm sleet, 比重 0.9

佐藤 春治

 東北電力株式会社
 電力流通本部
 電力システム部 (送電)
 課長 佐藤 春治

English

To TOKYOROPPE MFG. CO.,LTD

Tohoku Electric Power Co.,Inc
July 11th, 2014

Certification of Operation Record ACFR:Aluminium Conductor carbon Fiber Reinforced

Tohoku Electric Power Co., Inc certify the safe operation of Aluminium Conductor Carbon fiber Reinforced without any problem from the beginning of operation until now as shown below.

Table.1 Operation record of ACFR

Table 1 Operation record of ACFR																																																				
Record No.	1		2																																																	
Name of Branch office	Miyagi Branch		Niigata Branch																																																	
Line name/ span No.	66kV Kashimadai line No.5 ~ No.9		66kV Kashimadai line No.3 ~ No.5																																																	
Route Length	1,063m		462m																																																	
Location	Hieshuchi, Ishinomaki, Miyagi		Koshin, Nishi Ward, Niigata																																																	
Conductor type	ACFR 160mm ²		ACFR 160mm ²																																																	
Installed in	December 2002		October 2003																																																	
{Corrosion condition	0.25 mg/cm ²		0.50 mg/cm ²																																																	
Reason for choosing ACFR	To gain ground clearance		To gain ground clearance																																																	
Current Carrying Capacity	90℃: 454A, 120℃: 600A																																																			
Result: [Difference in sagging between ACSR and ACFR]	Conductor temperature: 90℃ <table><tr><th>Span length</th><th>ACSR(A)</th><th>ACFR(B)</th><th>(A) - (B)</th></tr><tr><td>S=200</td><td>5.08</td><td>3.70</td><td>1.38</td></tr><tr><td>S=250</td><td>7.27</td><td>5.66</td><td>1.61</td></tr><tr><td>S=300</td><td>9.88</td><td>8.04</td><td>1.84</td></tr><tr><td>S=350</td><td>12.91</td><td>10.83</td><td>2.08</td></tr><tr><td>S=400</td><td>16.38</td><td>14.03</td><td>2.35</td></tr></table> Conductor temperature: 120℃ <table><tr><th>Span length</th><th>ACSR(A)</th><th>ACFR(B)</th><th>(A) - (B)</th></tr><tr><td>S=200</td><td>5.76</td><td>3.73</td><td>2.03</td></tr><tr><td>S=250</td><td>8.03</td><td>5.70</td><td>2.33</td></tr><tr><td>S=300</td><td>10.70</td><td>8.09</td><td>2.61</td></tr><tr><td>S=350</td><td>13.78</td><td>10.88</td><td>2.90</td></tr><tr><td>S=400</td><td>17.29</td><td>14.00</td><td>3.20</td></tr></table>				Span length	ACSR(A)	ACFR(B)	(A) - (B)	S=200	5.08	3.70	1.38	S=250	7.27	5.66	1.61	S=300	9.88	8.04	1.84	S=350	12.91	10.83	2.08	S=400	16.38	14.03	2.35	Span length	ACSR(A)	ACFR(B)	(A) - (B)	S=200	5.76	3.73	2.03	S=250	8.03	5.70	2.33	S=300	10.70	8.09	2.61	S=350	13.78	10.88	2.90	S=400	17.29	14.00	3.20
Span length	ACSR(A)	ACFR(B)	(A) - (B)																																																	
S=200	5.08	3.70	1.38																																																	
S=250	7.27	5.66	1.61																																																	
S=300	9.88	8.04	1.84																																																	
S=350	12.91	10.83	2.08																																																	
S=400	16.38	14.03	2.35																																																	
Span length	ACSR(A)	ACFR(B)	(A) - (B)																																																	
S=200	5.76	3.73	2.03																																																	
S=250	8.03	5.70	2.33																																																	
S=300	10.70	8.09	2.61																																																	
S=350	13.78	10.88	2.90																																																	
S=400	17.29	14.00	3.20																																																	
Line condition	No change has been observed, Maintain good condition since installation. Running without any problem		No change has been observed, Maintain good condition since installation. Running without any problem																																																	

Corrosion condition means assumed salt deposit density

Calculation condition Maximum tension in use: 25.5kN

[Summer season] Wind pressure: 980Pa, 15℃ [Winter season] Wind pressure: 490Pa, -15℃, 6mm sleet, Density: 0.9

 Haruji Sato
 Tohoku Electric Power Co., Inc.
 Electricity transmission division
 Electricity system section (transmission)
 Haruji Sato (Seal)

Project Profile : Ampacity Upgrade

Project Overview

Customer	China Southern Power Grid
Project	Hainan Island City
Location	Hainan Island / China
Year Installed	2013 (Energized)
Conductor Length	60 KM
Voltage	220 kV

Solution

ACFR 320/40 (Trapezoidal Shaped Annealed AL)

Result

Doubled capacity of line while maintaining clearances

Used existing towers without modification

Maintained existing right of way

Saved time for installation



Operation Certification from China

Chinese

“倍容导线在海南电网的研究与应用” 项目使用情况报告

2012年海南电网海口供电局根据电网改造要求,对南网特维线路”220kV 福丰1线”进行了增容技术改造工程,选用的是佛冈鑫源恒业电缆科技有限公司生产和配套的绞合型碳纤维铝导线 JLRX1/JFB-320/40 及压接型金具,线路全长 18.9km,整个改造工程用绞合碳纤维芯软铝绞线 59.567km,最大耐张段长度 4682 米,最大导线单段制造长度 5018 米,导线施工周期 18 天;于 2013 年 7 月 2 日挂网运行。

整个工程安装方便,特别是压接型金具操作简单,安全,快速,整条线路使用近半年没发生一次问题,经历数次台风洗礼(包括今年历史上最大台风海燕),最大电流 1040A,弧垂及导线温度参数均符合设计要求。

我公司对这种导线是第一次使用,从技术参数及安装使用情况来说,此种导线是一种值得研究使用的新型节能导线。

海南电网海口供电局

2013年7月2日

English

TOKYO ROPE MFG.CO.,LTD.
September, 2015
Item 4-2

(TRANSLATION – Chinese to English)

Re: Project Report for research and applications on double-carrying capacity conductor cable at Haina Power Grid Corp.

Hainan Power Grid Corp. Haikou Power Distribution Div. conducted revamping of transmission capacity enhancement on “220kV Fufeng Line 1” complying to electricity users’ demand. JLRX1/JFB-320/40 type conductor cable and accessories, produced by Fogang Xinyuan Hengye Cable Technology Co.,Ltd. in Guangdong Providence, was used for this project in replacement of existing conductor cable line. JLRX1/JFB-320/40 is type of conductor cable made from soft annealed aluminum, reinforced by carbon fiber composite core, and dead-end clamp to be installed by compression. Route length is 18.9km and total length of conductor cable is 59.567km. The longest span between dead-end clamps is 4,682m. Production unit of conductor cable was 5,018m. Stringing work was done in 18days and electric current operation has started on July 2nd 2013.

It was reported that stringing work has been done smooth and easy, particularly, installation of dead-end clamp by pressing die has been done simple, quick and safe. After revamping on July 2nd, 2013, although this line was hit by typhoon for many times including the strongest one ever in the history, the line has been in good and safe operation without any problem as of this date. Carrying 1,040A at maximum, sagging, temperature and other requirements have been within designed and satisfactory level.

This was the first time to make use of this conductor cable for our company, and this cable was reconfirmed to be worth while applying for actual operations as new energy-saving type cable, considering various aspects of this cable, including high standard of technology, easy and smooth handling and installation, and actual operational data.

Hainan Power Grid Corporation,
Haikou Power Distribution Division
Industrial Technology Department
December 1st 2013

Project Profile : Ampacity Upgrade

Project Overview

Customer	PLN
Project	Binjai – Pangkalan Brandan
Location	Medan / Indonesia
Year Installed	2015 (Energized) and 2018 (Installing)
Conductor Length	350 km for 2015 and 350 km for 2017
Voltage	150 kV

Solution

ACFR 315/40 (Trapezoidal Shaped Annealed AL)

Result

Doubled capacity of line while maintaining clearances

Used existing towers without modification

Maintained existing right of way

Saved time for installation



Operation Certification from PLN

Indonesian

PT PLN (PERSERO)
PENYALURAN DAN PUSAT PENGATUR BEBAN SUMATERA

Jalan Jendral Sudirman / Nangka Ujung Kel. Labuh Baru Barat Kec. Payung Sejahtera, Pekanbaru 28233 Riau
 (0761) 8700011, 8700012 Email : p3bs@pln.co.id Facsimile : (0761) 8700015
 Website : www.pln.co.id/p3bs

Surat Sdr. No. : 0542 /KON.02.02/P3BS/2017 04 Desember 2017
 Karakteristik : Penting
 Prioritas :
 Tujuan : Surat Keterangan

Kepada
 PT Voksel Electric
 Jl. Narogong km 16, Cileungsi
 Bogor 16820

u.p. Direktur


Menunjuk surat dari Saudara No. 225/L/KL/XI/2017 tanggal 06 November 2017 perihal surat keterangan sukses operasi, dengan ini disampaikan bahwa PT PLN (Persero) P3B Sumatera telah menggunakan konduktor HTLS Produk PT Voksel Electric berupa

Nama Konduktor : Aluminium Conductor Fiber Reinforced (ACFR)
 Ukuran : 315/40 mm²
 Telah beroperasi sejak : 03 April 2016

Sesuai dengan Kontrak No. 0097.PJ/KON.02.02/P3BS/2015 tanggal 13 Agustus 2015 pekerjaan SUTT 150 kV Kualatanjung - Kisaran sirkuit 1 & 2 (57 kmr) dari ACSR 1x2 mm² dengan HCLS konduktor yang kemampuannya 2 kali eksisting.

Demikian Surat Keterangan ini dibuat untuk dapat dipergunakan seperlunya, atas perhatian dan kerjasamanya diucapkan terima kasih.

PLH GENERAL MANAGER
 MANAJER OPERASI SISTEM


 ASEP SAMSUDIN

English Translation

Number : 0582/KON.02.02/P3BS/2017 4 December 2017
 Reference No :
 Nature : Urgent
 Regarding : Statement Letter

To:
 PT Voksel Electric
 Jl Narogong KM 16, Cileungsi
 Bogor 16820

Attention : Director

In replying your letter No 225/L/KL/XI/2017, Date: 6 November 2017 about request of Success Operation Letter, with this PT PLN (Persero) P3B Sumatera confirmed that HTLS Conductor

Conductor Name : Aluminum Conductor Fiber Reinforced (ACFR)
 Size : 315/40 mm²
 Commencement Date : 3 April 2016
 Contract No : 0097.PJ/KON.02.02/P3BS/2015, Date: 13 August 2015
 Project Name : Reconductoring SUTT 150 kV Kualatanjung – Kisaran Circuit 1 & 2 (57 KMR) from ACSR 1x240mm² to HCLS Conductor with double the existing ampacity

Was produced by PT Voksel Electric

This letter of statement shall be used for the right purpose. Thank you for your corporation

Acting General Manager
 Manager of Operation & System

Asep Samsudin

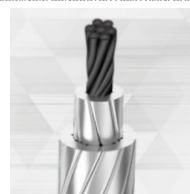
Our Business Model with



CFCC



ACFR



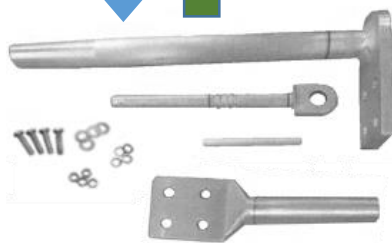
Supporting
ACFR Design
ACFR Production

Conductor
Maker

EPC

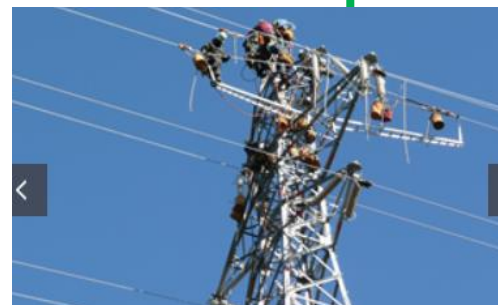
Electric
Company

Providing
CFCC gripping
Technology



Fittings

Supervising
Hardware installation
Stringing work



Stringing Support

Stringing Advisor

■ Stringing Lecture

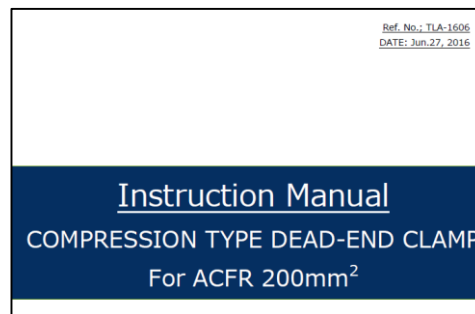
■ Job Site Observation

Manual to be provided

Stringing



Hardware



Installation Video



Summary

- HTLS solution is attracting attention especially in Asia are
- ACFR is the best solution among HTLS conductor
- ACFR's hardware and Installation process is close to standard ACSR

Thank you !

TOKYO ROPE INTERNATIONAL INC.