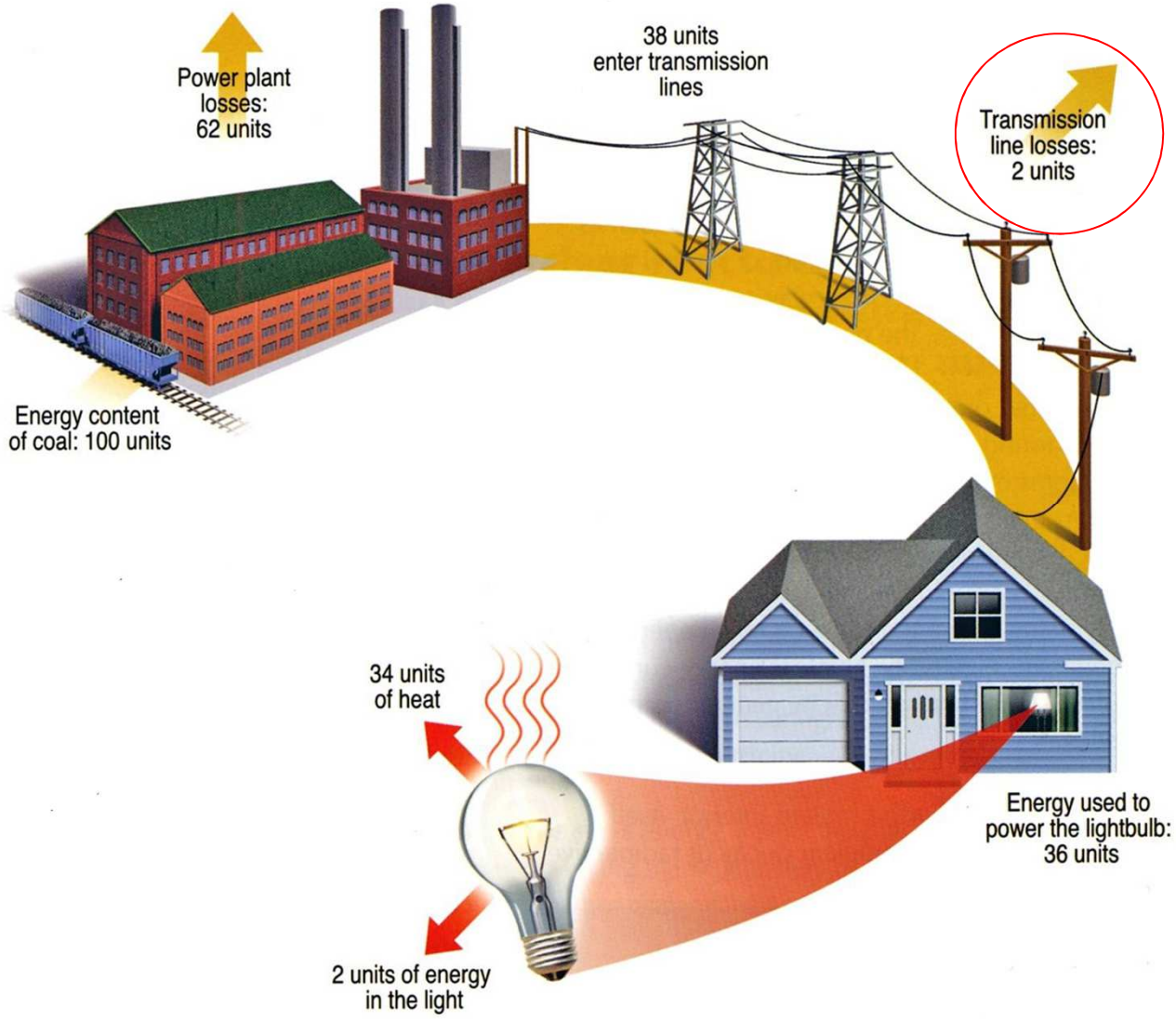
Szigeteletlen szabadvezetékek fejlesztésének tapasztalatai és eredményei a FUX Zrt-nél

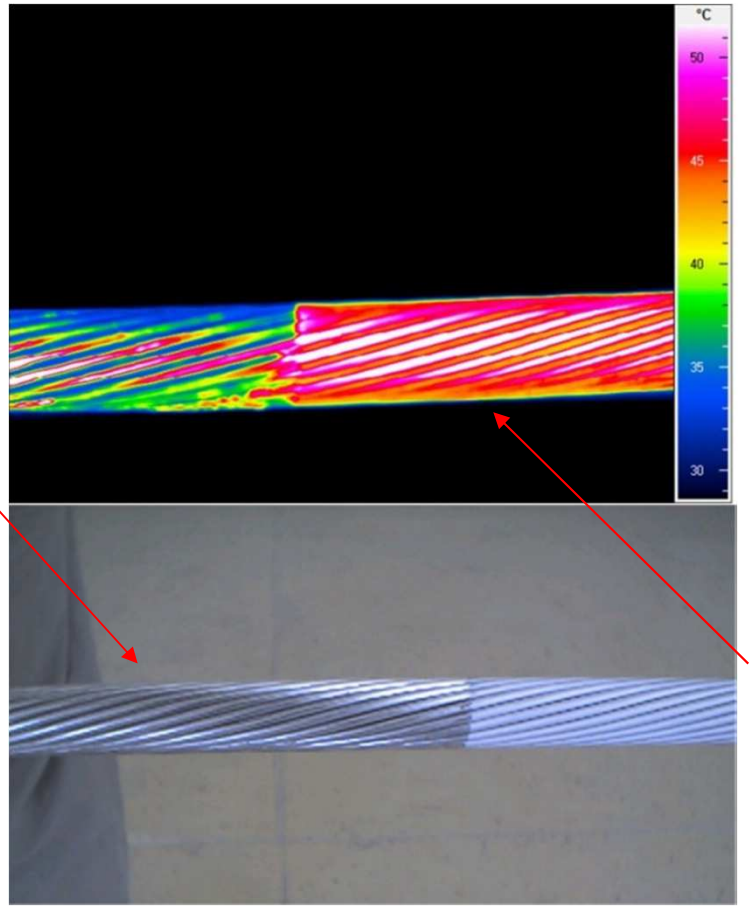

Power plant losses: 62 units
38 units enter transmission lines
Transmission line losses: 2 units
Energy content of coal: 100 units
34 units of heat
Energy used to power the lightbulb: 36 units
2 units of energy in the light

in moist weather in the originally hydrophobic surface the water forms lar

It could be decreased by the surface treatment of a conductors.

In moisty weather the corona loss is a significant part of the total loss.

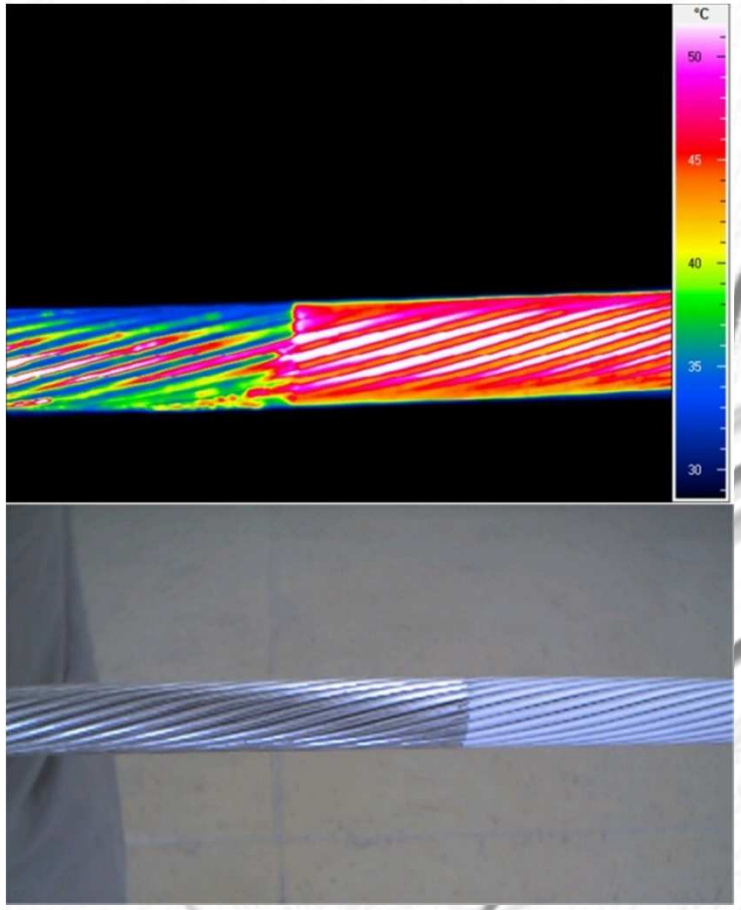
line voltage kV	load MVA	I^2R loss kW/km	corona loss kW/km
362	400	41	26
550	900	52	78
800	2000	93	208



normal

treated

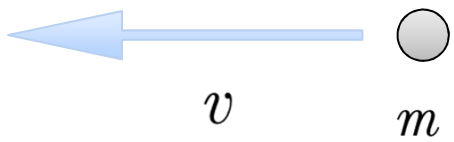
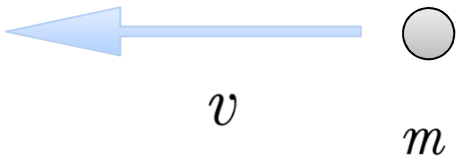
The emissivity of the surface treated conductor is 0.8 without it 0.2



I(80°C)=1390A (100%)

I(80°C)=1550A (111%)

Additional increment in current capacity

Conductor Al or Cu	Ice	Water	aerosol, waterdrops 
Conductor Al or Cu	Rime		aerosol, waterdrops 

Conductor

Al or Cu

$$\rho_{Cu} C_{cu} \frac{\partial T}{\partial t} = k_{Cu} \frac{\partial^2 T}{\partial x^2}$$

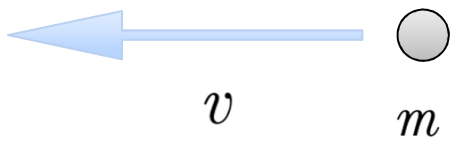
Ice

$$\rho_{jeg} C_{jeg} \frac{\partial T}{\partial t} = k_{jeg} \frac{\partial^2 T}{\partial x^2}$$

Water

$$\rho_{viz} C_{viz} \frac{\partial T}{\partial t} = k_{viz} \frac{\partial^2 T}{\partial x^2}$$

aerosol, waterdrops



$$k_{jeg} \frac{\partial T}{\partial x} = H_{viz/jeg}(T_{jeg} - T_{viz}) + \widehat{m} L$$

$$k_{viz} \frac{\partial T}{\partial x} = H_{viz/jeg}(T_{jeg} - T_{viz}) + \widehat{m} L$$

$$Q_{as} = \frac{1}{2} \overline{m} v^2 + \frac{r H_{viz/levego} v^2}{2 C_{levego}}$$

$$k_{cu} \frac{\partial T}{\partial x} = H_{Cu/jeg}(T_{jeg} - T_{Cu})$$

$$k_{jeg} \frac{\partial T}{\partial x} = H_{Cu/jeg}(T_{jeg} - T_{Cu})$$

$$Q_{viz} = (\overline{m} C_{viz} + \lambda_e e_o + H_{levego/viz})(T_{levego} - T)$$

$$k_{jeg} \frac{\partial T}{\partial x} = Q_{as} + Q_{viz}$$

Conductor

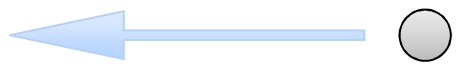
Al or Cu

$$\rho_{Cu} C_{cu} \frac{\partial T}{\partial t} = k_{Cu} \frac{\partial^2 T}{\partial x^2}$$

Ice

$$\rho_{jeg} C_{jeg} \frac{\partial T}{\partial t} = k_{jeg} \frac{\partial^2 T}{\partial x^2}$$

aerosol, waterdrops



v m

$$k_{cu} \frac{\partial T}{\partial x} = H_{Cu/jeg}(T_{jeg} - T_{Cu})$$

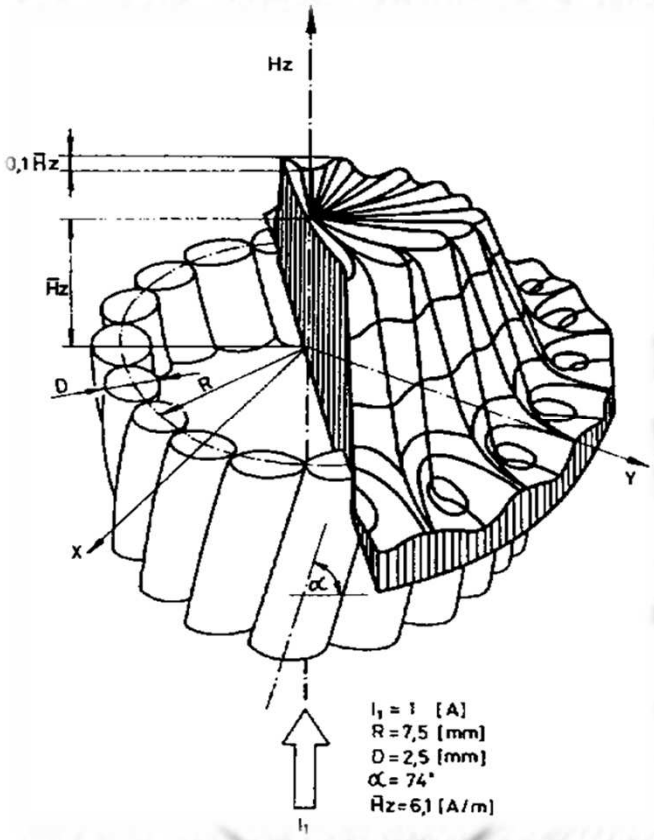
$$k_{jeg} \frac{\partial T}{\partial x} = H_{Cu/jeg}(T_{jeg} - T_{Cu})$$

$$Q_{as} = \frac{1}{2} \overline{m} v^2 + \frac{r H_{jeg/levego} v^2}{2 C_{levego}} + \overline{m} L$$

$$Q_{jeg} = (\overline{m} C_{viz} + \lambda_s e_o + H_{levego/jeg})(T_{levego} - T)$$

$$k_{jeg} \frac{\partial T}{\partial x} = Q_{as} + Q_{jeg}$$

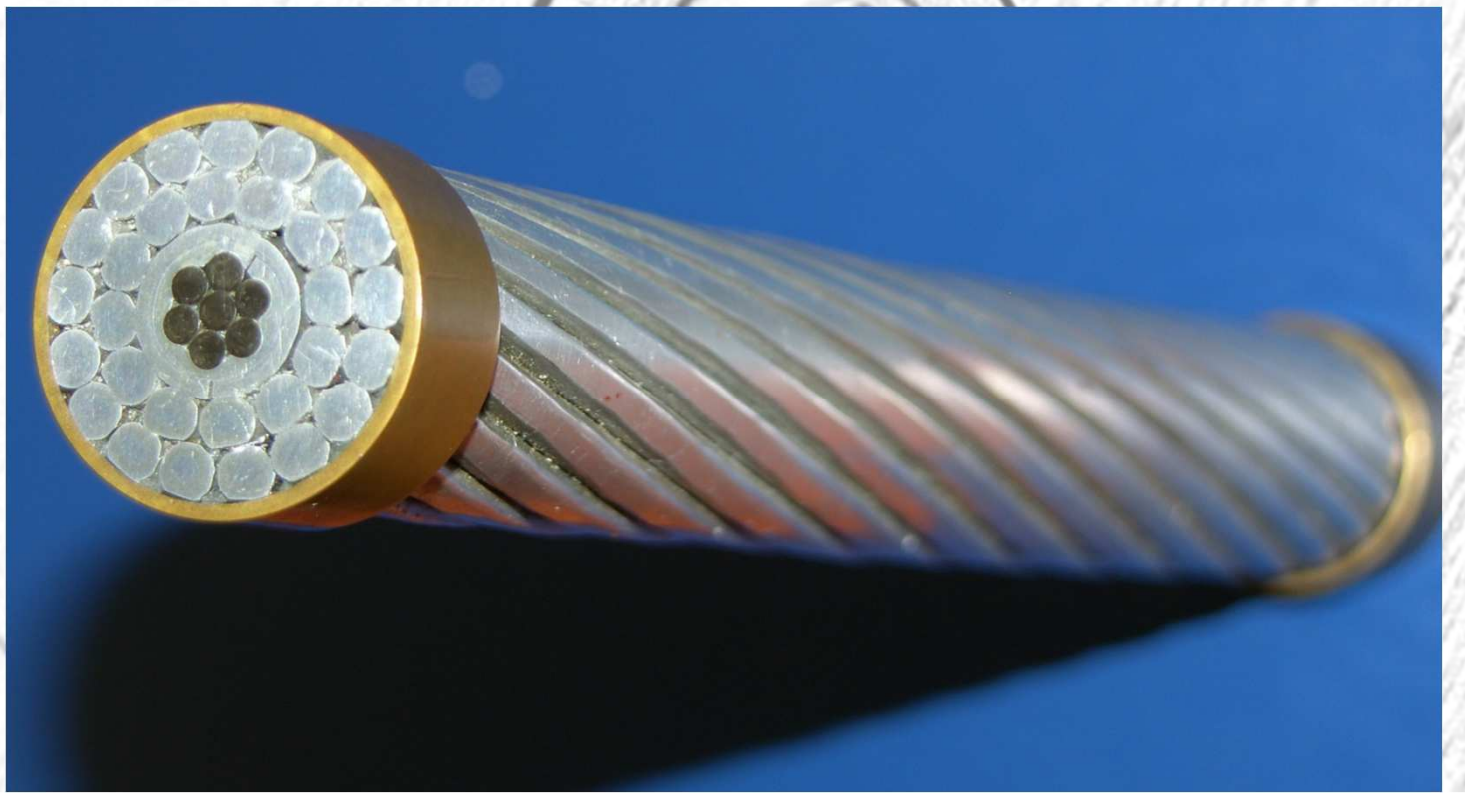
The magnetic field in steel core of ACSR is depend on the stranding parameters of aluminum wires.



The magnetic field in the steel core cause loss.

Type ACSR 500/65	Non-compensated standard	Compensated Low loss, low corona nois, high emission	Difference
Construction	1+6 steel 12+18+24 aluminium	1+6 steel 12+18+24 aluminium	
Wire diameter	3.45 mm	3.45 mm	-
Conductor diameter	31.05 mm	31.05 mm	-
Mass	1919 kg/km	1914 kg/km	5 kg/km decrease in alu mass
DC resistance (20°C)	0.05656 ∧ /km	0.05633 ∧ /km	0.4 % decrease
AC resistance (80°C)	0.0738 ∧ /km	0.0710 ∧ /km	3.8 % decrease
Power loss (3 phases, 80°C; 1560 A)	539 kW/km	517 kW/km	22 kW/km decrease in power loss
E modul	71.6 kN/mm^2	71.6 kN/mm^2	-
UTS	155.3 kN	155.3 kN	-
Loading current (80°C, winter)	1400 A	1560A	11% increase in current capacity

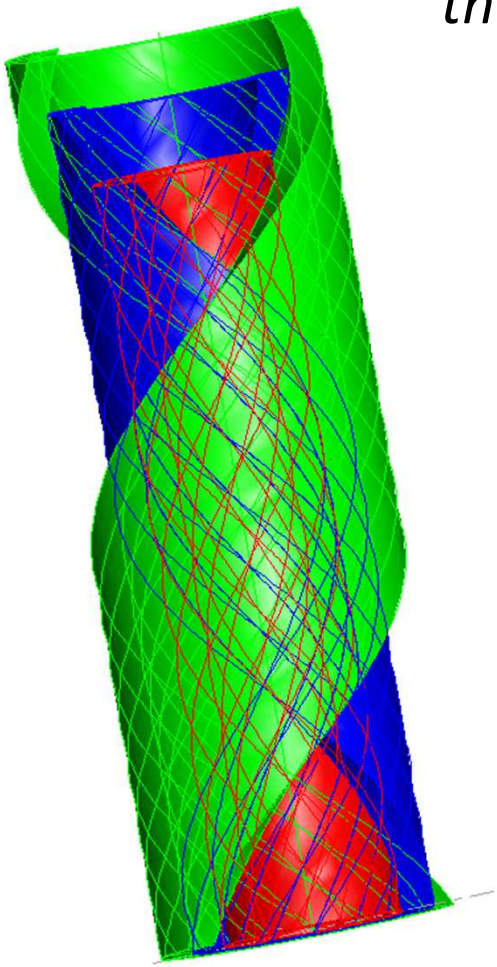
The applied roboust solution for the enhanced corrosion resistance also increase the conductive cross section. Adiitionally it is intensified by the compacting of the conductor. The compacting lowered a corona radion of the conductor too.

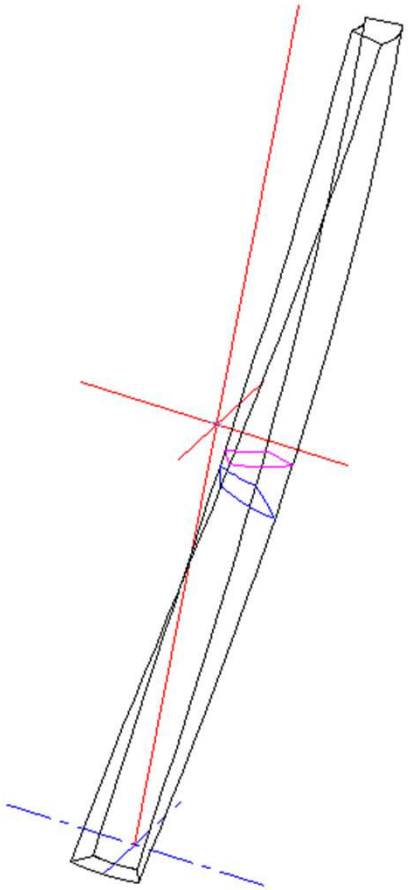


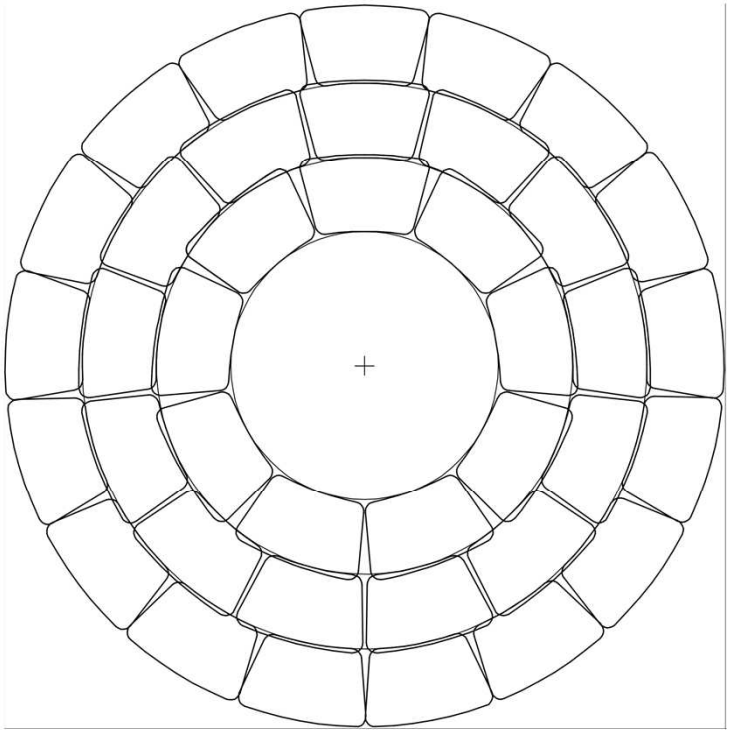
Type	ACSR 500/65 standard	KORAL 600/56 Low loss, low corona noise,	Difference
Construction	1+6 steel 12+18+24 aluminium	1+6 steel 12+18 compact aluminium	
Wire diameter	3.45 mm	Compact	-
Conductor diameter	31.05 mm	31.05 mm	-
Mass	1919 kg/km	2063 kg/km	144 kg/km increase
DC resistance (20°C)	0.05656 ∧ /km	0.04745 ∧ /km	16 % decrease
AC resistance 1400 A (80°C/53°C)	0.0738 ∧ /km (80°C)	0.05471 ∧ /km (53°C)	26 % decrease
Power loss (3 phases, 80°C/53°C; 1400 A)	434 kW/km	322 kW/km	112 kW/km decrease in power loss
E modul	71.6 kN/mm^2	65.8 kN/mm^2	-
UTS	155.3 kN	180.4 kN high strengs Core	-
Loading current (80°C, winter)	1400 A	1695 A	21% increase in current capacity

The conductive cross section is extremly higher with the shaped aluminum wires.

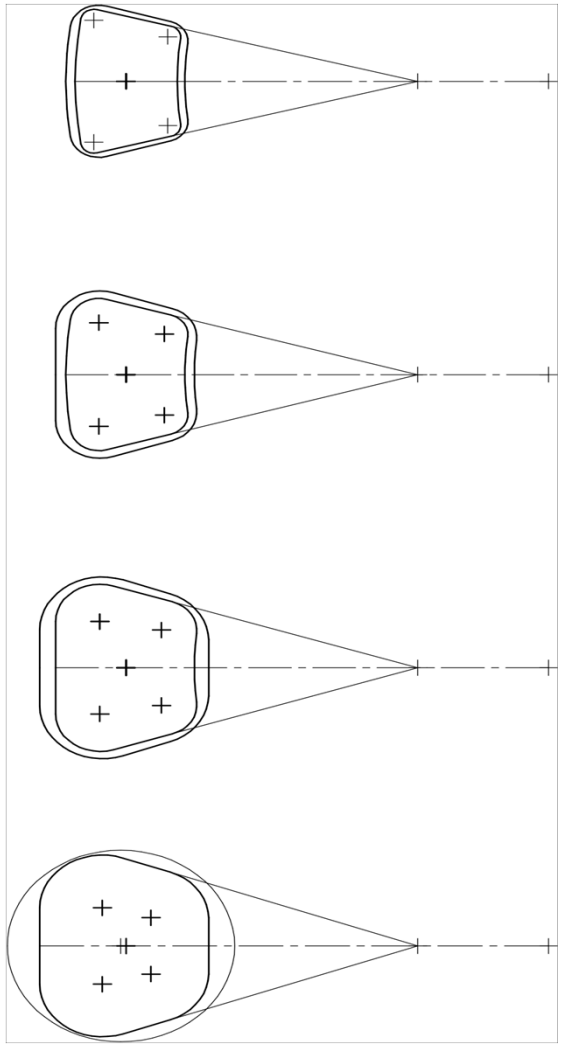
Geometrical planning is necessary for the production for the best properties and quality.



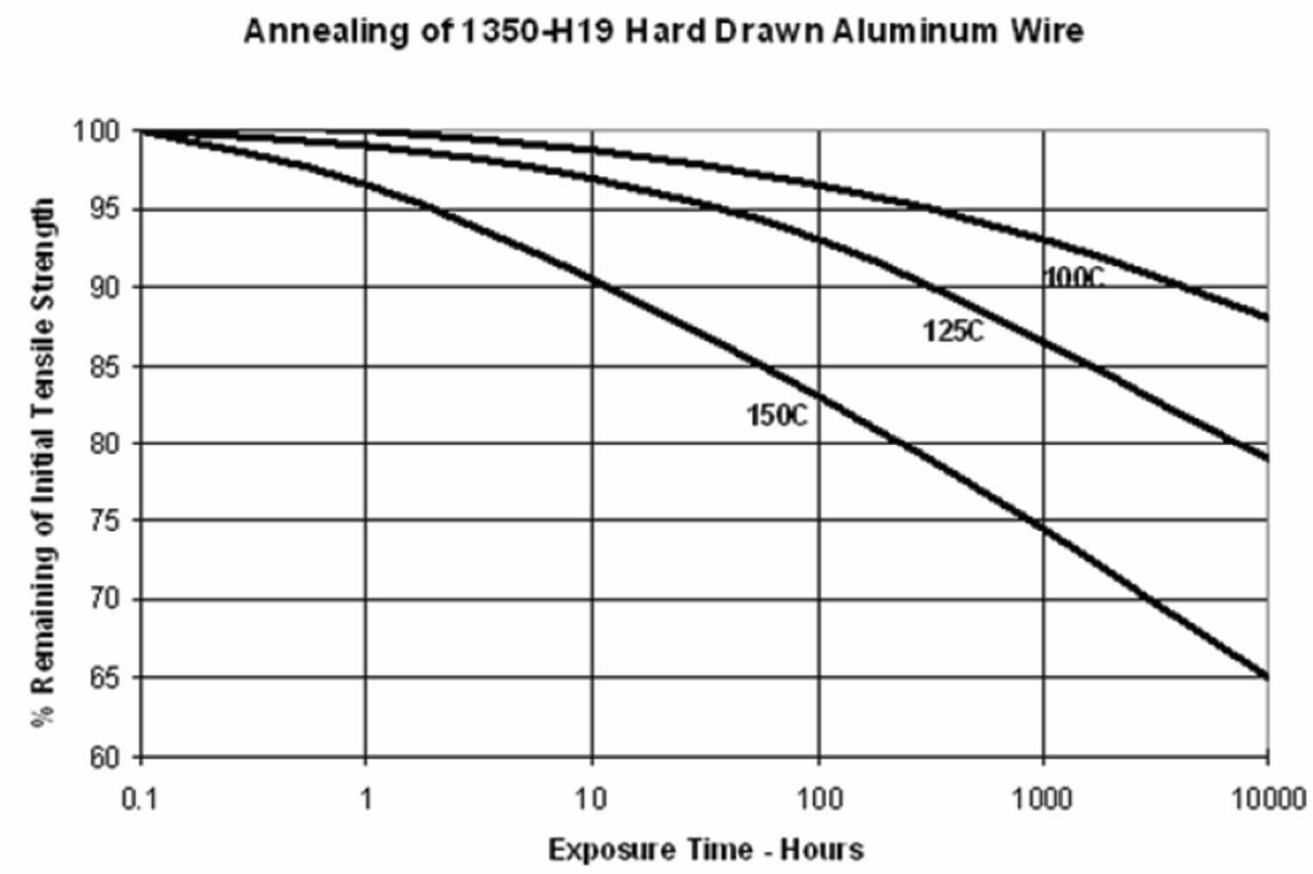




In wire drawing the trapezodial shape can be reached in more drawing-step.



The maximal operating temperature means a limit in amapcity of the conductors due to the softening of hard aluminum wires in elevated temperature.



The high tempetature low sag conductors means a solution.

- ***GAP:*** *high strength steel core and heat resistant aluminum wires. The core and the layers of aluminum wires can be freely displacing to each other due to the gap between th core and aluminum wires. (fig 1.)*
- ***ZTACIR:*** *INVAR aluminum clad steel core and heat resistant aluminum wires (ig. 2.)*
- ***ACSS:*** *any type of steel core and fully annealed aluminum wires (fig. 2.)*
- ***ACCR és ACCC:*** *composite core and heat resistant or fully annealed aluminum wires (fig. 3.)*

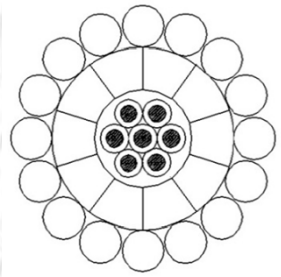


fig. 1.

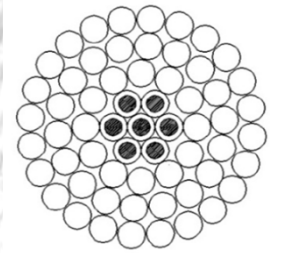


fig. 2.

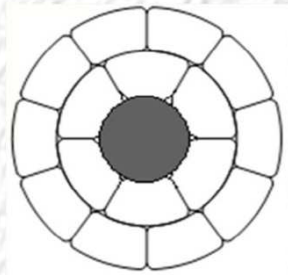


fig. 3.

Type	Price	Temperature of breakpoint	Alumínium	Max. operating temp.	Installation
GAP	low	at the temperature of installation (simple controll)	heat resistant	150-210	special pull-up, normal handling, standard fittings
ACSS	low	Depends on the stresses (difficult to determine, tipically in the range 40-60°C). Adjustable by the pre-straining.	softened	250	normal handling, high danger of play-open, special pull-up, standard fittings, pre-straining.
ZTACIR	high	at high temperature	heat resistant	210	normal handling, pull-up and fittings
ACCC	high	Depends on the stresses (difficult to determine, tipically in the range 40-60°C). Adjustable by the pre-straining.	softened	160	new materials, few experience, special fittings, special pull-up, danger of splay-open.
ACCR	extremly high	at high temperature	heat resistant	210	new materilas, few ecperience, patent (1 manufacturer), normal handling and pull-up.


Belógás (T=20°C)


ACSS 242/39
Belógás (T=150°C)
ACSR 242/39

ACSS 242/39

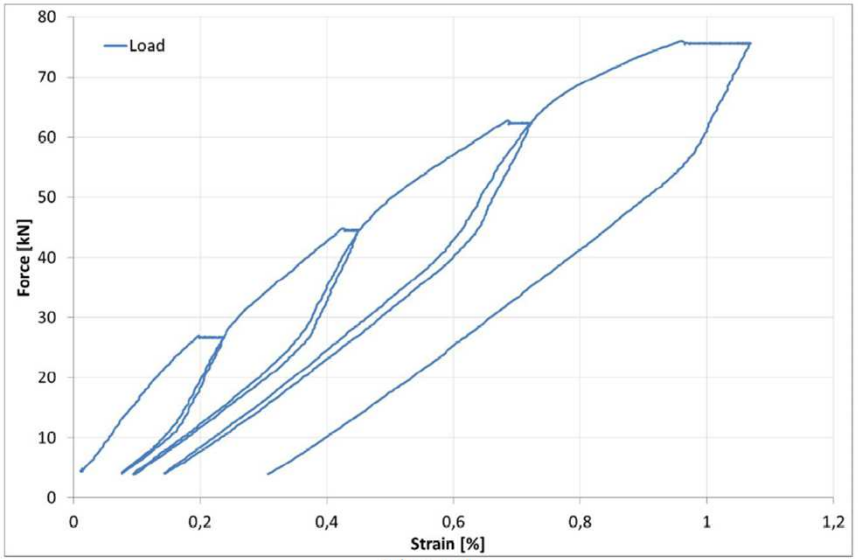


Diagram 1
Force-Strain curve (Conductor)

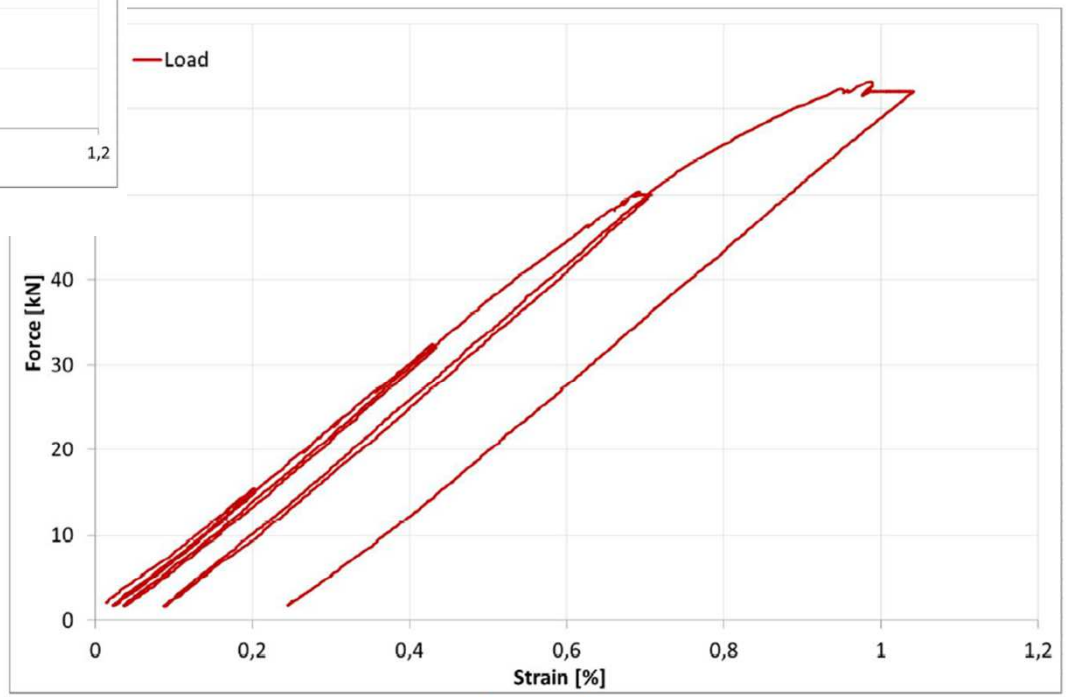
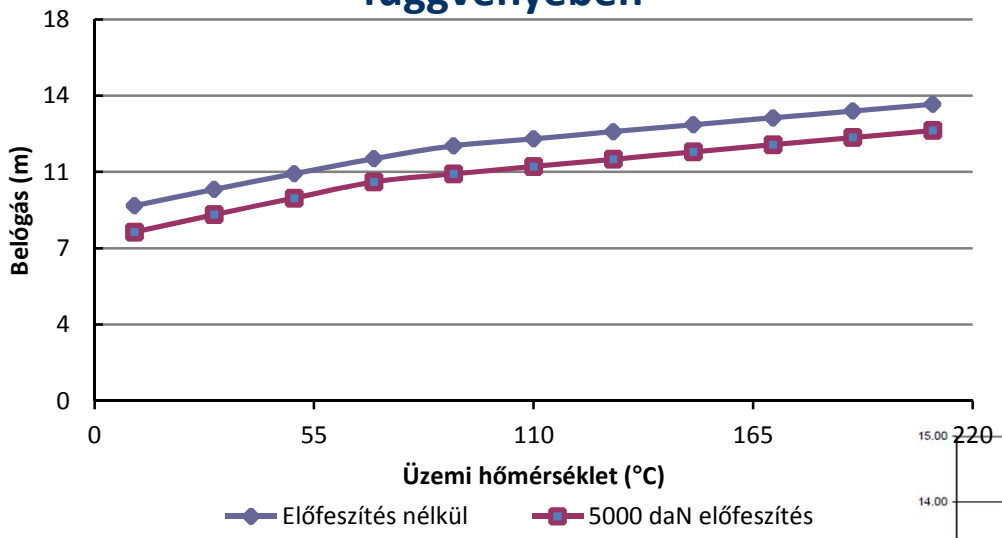
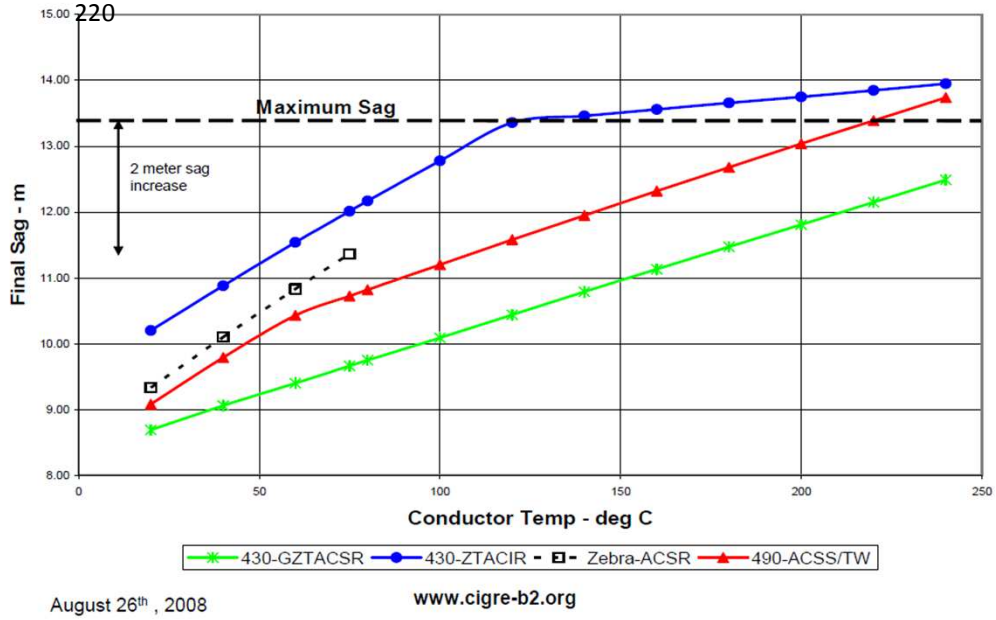


Diagram 2
Force-Strain curve (Steel Core)

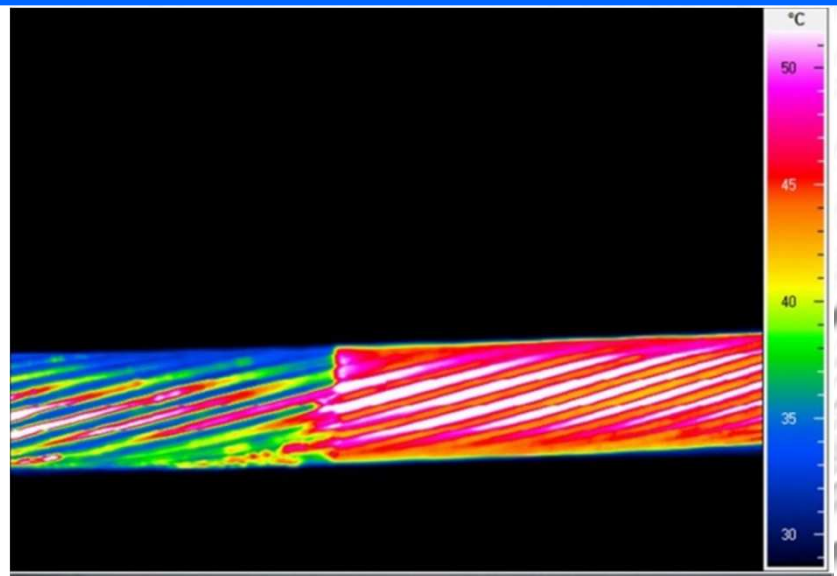
ACSS 426/55 vezeték belógása a hőmérséklet és előfeszítés függvényében

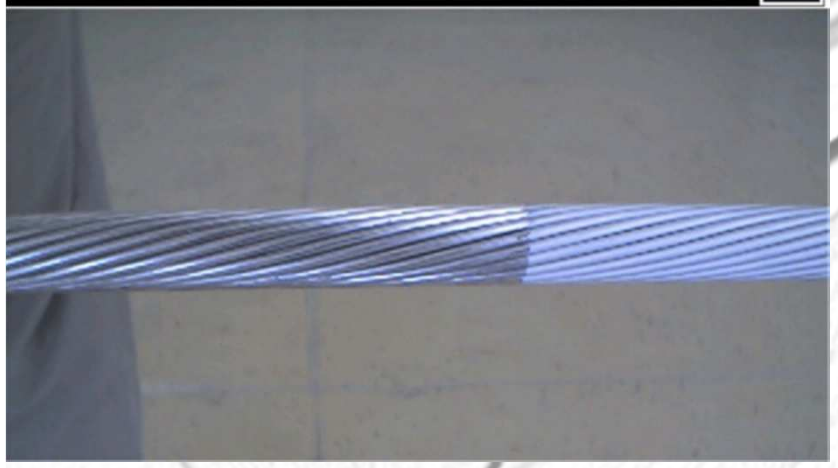


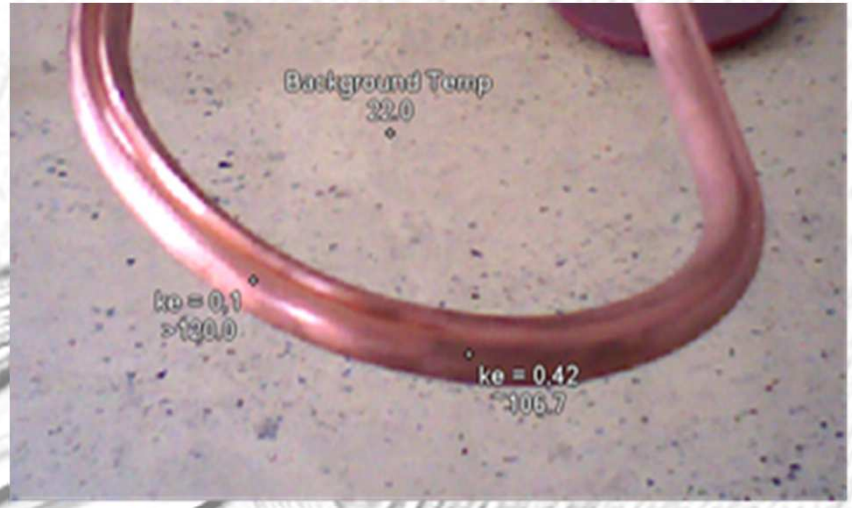


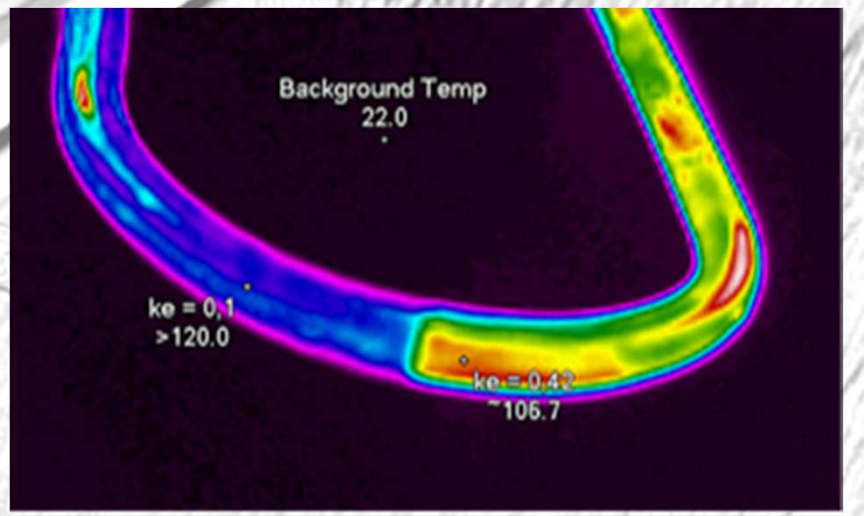

S
PIVKA
S

Same treatment
same effect

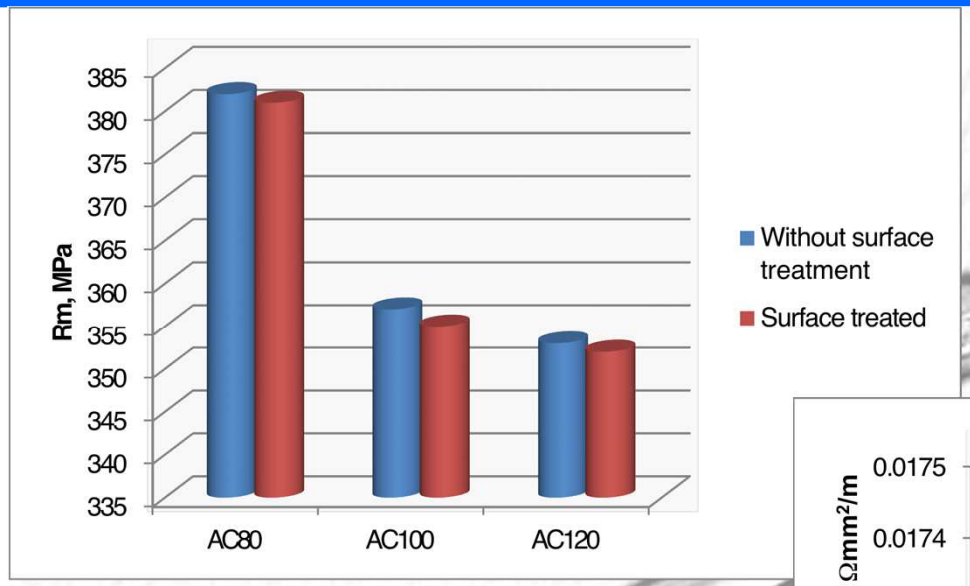


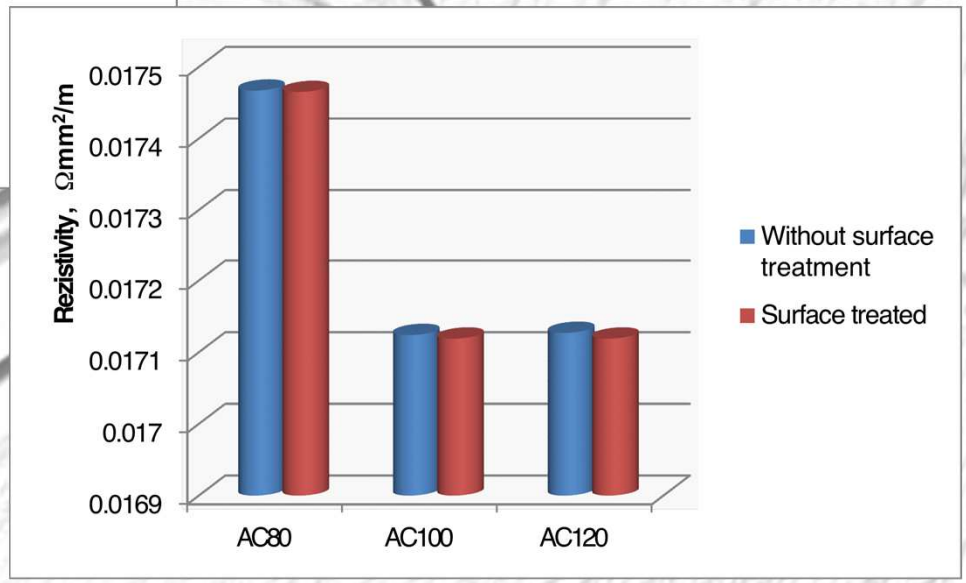




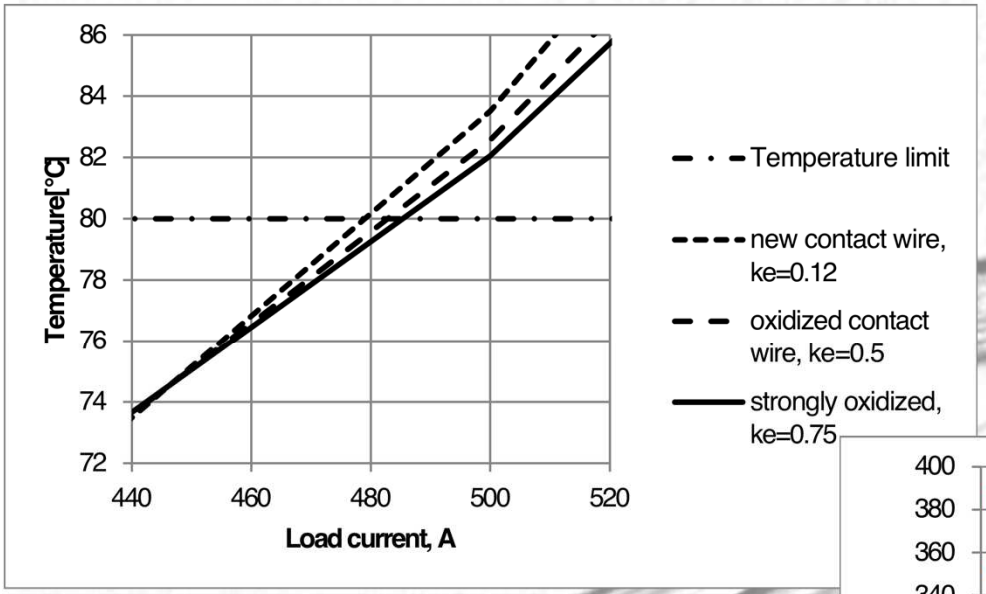


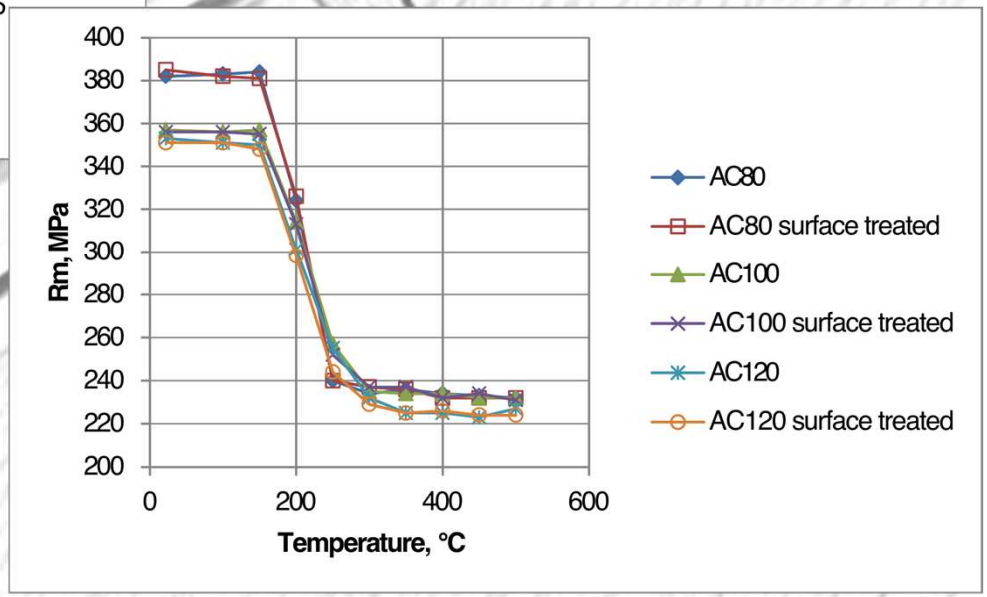
The surface treatment gives the same advantages as the ACSR conductors.





The surface treatment does not change the mechanical and electrical properties of the contact wires.



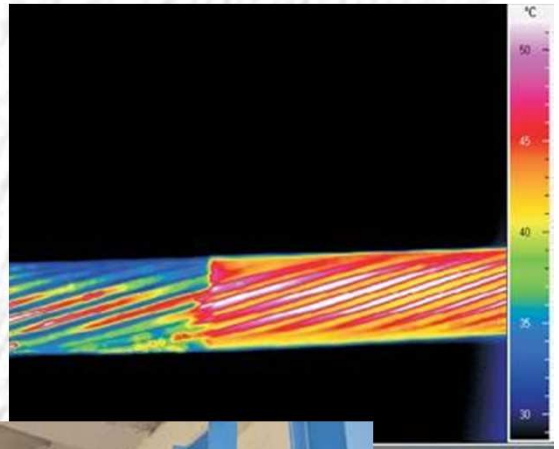


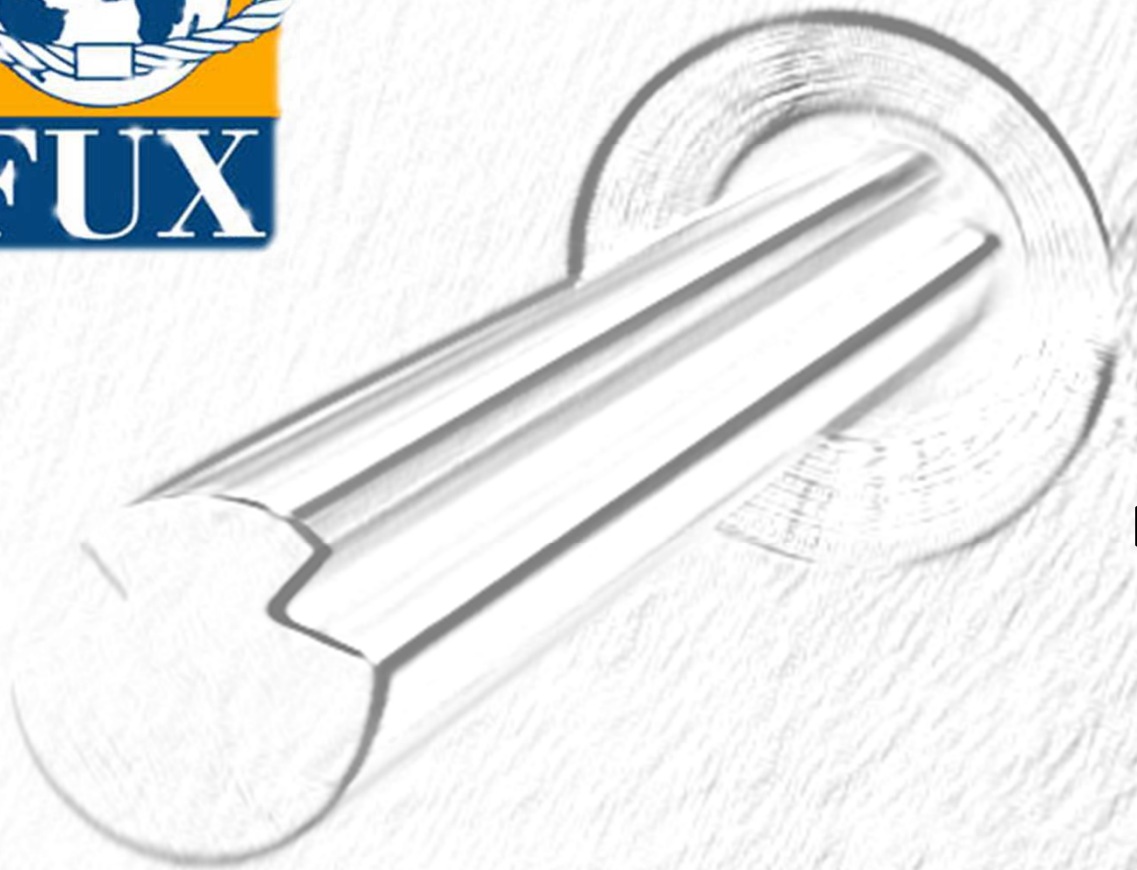
The newly manufactured contact wire operates as a very old one with full cross section.

Quality testing - factory tests

Wire rope and Conductor diagnostics - joint laboratory with University of Miskolc

- tensile and stress - strain test
- high current tests (transient and steady state)
- creep tests
- vibration tester
- fatigue test (only for lifting and elevators)
- corrosion tester (salt fog)





FUX Co.
Miskolc
Besenyői street 8.
3527 Hungary
www.fux.hu
fux@fux.hu
+36-46-501-850