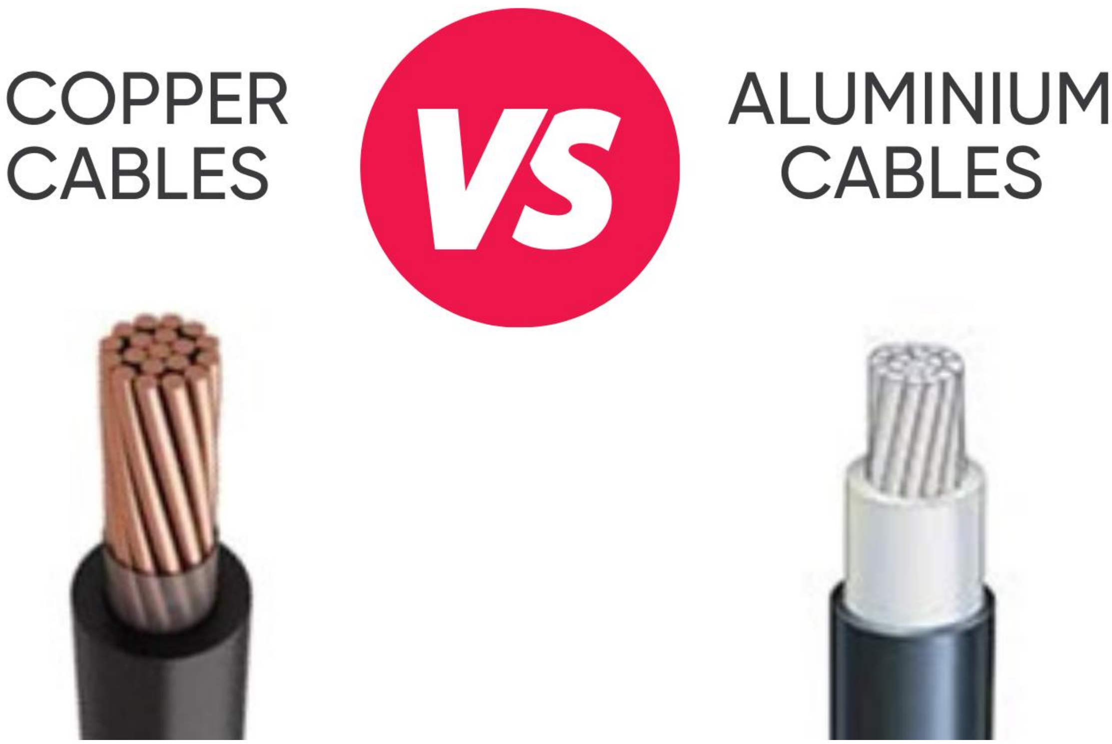
یەکێتی ئەندازیارانی کوردستان
Kurdistan engineering union
اتحاد مهندسي كوردستان



Prepared by : -

Wshiar Hamarahim saeed

Card NO. 1668

Contents:-

Prepared by:- Wshiar Hamarahim saeed

Introduction:-

Cables are indispensable components of modern infrastructure, facilitating the transmission of energy, signals, and data across various applications. Essentially, a cable is a structured assembly of wires, fibers, or conductors bound together within a protective casing, designed to efficiently convey electricity, telecommunications signals, or other forms of information.

At its core, a cable comprises one or more conductors, typically crafted from materials like copper, aluminum, or fiber optics, encased within insulating materials. These conductors serve as pathways for electrical currents or optical signals, while the insulation shields against electrical interference and prevents energy leakage. Surrounding the conductors and insulation, there's often an outer layer known as the sheath, which provides additional protection against physical damage, moisture, and environmental factors.

The applications of cables are extensive, spanning telecommunications, electricity distribution, networking, and transportation systems. They manifest in diverse types and configurations tailored to specific functions, such as coaxial cables for transmitting television signals, Ethernet cables for networking computers, power cables for distributing electricity, and fiber optic cables for high-speed data transmission over long distances.

The design and composition of cables vary according to factors such as intended use, environment, and desired performance characteristics. With advancing technology, cables continuously evolve to meet the escalating demands for faster speeds, increased bandwidth, and heightened reliability in communication and energy transmission systems.

In essence, cables form the backbone of modern connectivity, enabling the seamless exchange of information and power essential for the functioning of contemporary society.

Copper as a cable & History of it

Copper cables are widely used for transmitting electrical signals and power. These cables consist of multiple strands or wires of copper metal bundled together. Copper is an excellent conductor of electricity, making it an ideal material for transmitting electrical signals with minimal loss.

The invention of copper cables dates back to the early 19th century, closely tied to the development of telegraphy. The invention and implementation of the telegraph by Samuel Morse and others in the 1830s necessitated a reliable means of transmitting electrical signals over long distances. Initially, iron wires were used, but they proved to be inadequate due to their susceptibility to corrosion and poor conductivity.

In 1831, Michael Faraday discovered electromagnetic induction, laying the groundwork for the development of electrical communication systems. This discovery spurred further experimentation and innovation in the field of telegraphy. One significant breakthrough came in the mid-19th century with the introduction of copper cables for telegraph lines.

Copper was chosen for its superior conductivity and resistance to corrosion compared to iron. The first successful transatlantic telegraph cable, completed in 1858, utilized copper conductors insulated with gutta-percha, a natural latex derived from the sap of certain trees. This cable allowed for the transmission of telegraph messages between North America and Europe, revolutionizing communication across continents.

Over time, the use of copper cables expanded beyond telegraphy to include telephone lines, electrical power distribution, and data transmission. Copper remains a prevalent material for cables in various applications due to its conductivity, flexibility, durability, and relatively low cost compared to alternatives.Today, copper cables are used extensively in telecommunications networks, electrical wiring systems, computer networks, and numerous other applications where reliable transmission of electrical signals is required. Despite advancements in fiber optic technology, copper cables continue to play a vital role in modern infrastructure, especially for short to medium-distance transmissions.

Prepared by:- Wshiar Hamarahim saeed

Copper uses in wide range of voltage:

Copper cables are utilized across a wide range of voltage systems, including low, medium, and high voltage applications. The suitability of copper cables for different voltage levels depends on various factors such as the cable design, insulation material, conductor size, and installation requirements. Here's an overview of how copper cables are used in different voltage systems:

1. Low Voltage Systems:
   - Low voltage systems typically refer to electrical systems with voltages up to 1000 volts (V). These include residential, commercial, and light industrial applications.
   - Copper cables are commonly used for low voltage applications due to their excellent conductivity and flexibility.
   - In low voltage systems, copper cables may range from small gauge sizes for household wiring to larger sizes for higher current loads in commercial and industrial settings.

2. Medium Voltage Systems:
   - Medium voltage systems typically operate within the range of 1000 volts (1 kV) to 35,000 volts (35 kV). These systems are commonly found in industrial and commercial settings, as well as in some utility distribution networks.
   - Copper cables are also suitable for medium voltage applications, especially for shorter distances and lower voltage levels within this range.
   - Medium voltage copper cables are designed with thicker insulation and larger conductor sizes to withstand higher voltages and currents.
   - These cables may be used for power distribution within industrial plants, substations, and urban distribution networks.

3. High Voltage Systems:
   - High voltage systems typically operate above 35 kV and can range up to hundreds of kilovolts (kV) for long-distance transmission and large-scale power distribution.
   - While copper has excellent conductivity, its use in high voltage transmission lines is limited due to factors such as cost and electrical losses.
   - In high voltage systems, aluminum cables are often preferred over copper due to their lower cost and lighter weight.
   - However, copper may still be used in certain high voltage applications, such as in high voltage transformers and some specialized power cables.

0,6/1 kV PVC insulated, single core cables, with copper conductor

Code: YVV-U, YVV-R, CU/PVC/PVC, NYY

U: Solid Conductor
R: Stranded Conductor

Standards: IEC 60502-1, VDE 0276-603

Technical Data

Max. operating temperature : 70°C
Max. short circuit temperature : (max. 5 sec.)
Cross section ≤300 mm^2 : 160°C
Cross section > 300 mm^2 : 140°C
Rated voltage : 0,6/1 kV
Min. bending radius : 12 x D
D : Cable outer diameter

Application

Indoor and outdoor applications, in cable ducts, underground, in power or switching stations, local energy distributions, industrial plants, where there is no risk of mechanical damage.

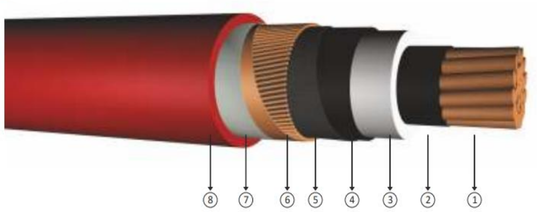
Construction

1. Solid or stranded copper conductor
2. PVC insulation
3. PVC outer sheath

DIMENSION AND WEIGHTS				ELECTRICAL PROPERTIES				
Nominal Cross Section	Overall Diameter (approx)	Net Weight (approx)	Delivery Length	DC Conductor Resistance at 20°C Max	Current Carrying Capacity (A)			
					In ground at 20°C		In air at 30°C	
mm²	mm	kg/km	m	Ω/km	***	***	***	***
1x1,5	5,8	50	1000	12,1	-	30	25	20
1x2,5	6,2	60	1000	7,41	-	39	34	27
1x4	7,0	85	1000	4,61	-	50	45	37
1x6	7,5	105	1000	3,08	-	62	57	48
1x10	9,0	160	1000	1,83	-	83	78	66
1x16	10,0	215	1000	1,15	127	107	103	89
1x25	11,5	320	1000	0,727	163	137	137	118
1x35	12,5	420	1000	0,524	195	165	169	145
1x50	14,0	570	1000	0,387	230	195	206	176
1x70	15,5	780	1000	0,268	282	239	261	224
1x95	18,0	1050	1000	0,193	336	287	321	271
1x120	19,5	1300	1000	0,153	382	326	374	314
1x150	21,0	1600	1000	0,124	428	366	428	361
1x185	23,5	1950	1000	0,0991	483	414	494	412
1x240	27,0	2550	1000	0,0754	561	481	590	484
1x300	30,5	3150	1000	0,0601	632	542	678	549
1x400	34,0	4200	1000	0,0470	730	624	817	657
1x500	37,0	5200	1000	0,0366	823	698	940	749
1x630	42,0	6450	500	0,0283	866	775	1042	858

Prepared by:- Wshiar Hamarahim saeed

12/20 kV or 12,7/22 kV XLPE insulated, single core, cables with copper conductor



Code: YXC7V-R, N2XSY, CU/XLPE/CWS/PVC

R: Stranded Conductor

Standards: IEC 60502-2, BS 7870-4.10

Technical Data

Max. operating temperature	: 90°C
Max. short circuit temperature	: 250°C (max. 5 sec.)
Rated voltage	: 12/20 kV 12,7/22 kV
Min. bending radius	: 15 x D
D	: Cable outer diameter

Application

These are cables with low dielectric losses used in energy networks with sudden load changes. Laid in residential or industrial areas, underground or in ducts.

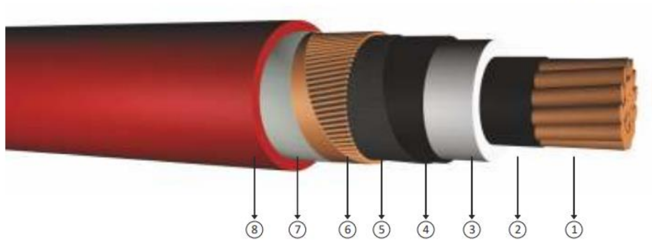
Construction

1. Stranded copper conductors
2. Inner semi conductive layer
3. XLPE insulation
4. Outer semi conductive layer
5. Semi conductive tape
6. Copper screen
7. PP tape
8. PVC outer sheath

DIMENSION AND WEIGHTS				ELECTRICAL PROPERTIES								
Nominal Cross Section	Overall Diameter (approx)	Net Weight (approx)	Delivery Length	DC Conductor Resistance at 20°C (Max)	DC Conductor Resistance at 90°C (Max)	Operation Inductance (approx)		Operational Capacitance (approx)	Current Carrying Capacity (A)			
									In ground at 20°C		In air at 30°C	
mm²	mm	kg/km	m	Ω/km	Ω/km	*** mH/km	*^* mH/km	µF/km	***	*^*	***	*^*
1x35/16	27,0	950	1000	0,524	0,6707	0,670	0,416	0,157	213	189	233	199
1x50/16	28,5	1150	1000	0,387	0,4954	0,644	0,397	0,174	250	223	279	238
1x70/16	30,0	1400	1000	0,268	0,3430	0,614	0,377	0,197	304	273	347	296
1x95/16	32,0	1650	1000	0,193	0,2470	0,590	0,360	0,218	361	325	420	358
1x120/16	34,0	1950	1000	0,153	0,1958	0,571	0,349	0,238	407	368	483	412
1x150/25	35,0	2350	1000	0,124	0,1587	0,554	0,338	0,258	445	410	540	466
1x185/25	37,0	2700	1000	0,0991	0,1268	0,538	0,329	0,278	498	463	614	534
1x240/25	39,5	3300	1000	0,0754	0,0965	0,518	0,317	0,308	569	534	718	627
1x300/25	42,0	3900	1000	0,0601	0,0769	0,501	0,308	0,336	633	601	813	715
1x400/35	45,5	5000	1000	0,0470	0,0602	0,480	0,298	0,377	686	674	904	819
1x500/35	48,5	6000	500	0,0366	0,0468	0,464	0,290	0,413	756	750	1011	927
1x630/35	52,5	7300	500	0,0283	0,0362	0,448	0,282	0,455	842	836	1128	1041

Prepared by:- Wshiar Hamarahim saeed

18/30 kV or 19/33 kV halogen free, flame retardant, XLPE insulated, single core, cables with copper conductor



Code: YXC7Z1-R, N2XSH, CU/XLPE/CWS/LSZH

R: Stranded Conductor

Standards: IEC 60502-2, BS 7870-4.10

Technical Data

Max. operating temperature	: 90°C
Max. short circuit temperature	: 250°C (max. 5 sec.)
Rated voltage	: 18/30 kV 19/33 kV
Min. bending radius	: 15 x D
D	: Cable outer diameter

Application

Used in energy networks in refineries, mines, hotels, schools, tunnels, high constructions, hospitals, power plant, data processing centers, business centers where there is a risk of fire.

Construction

1. Stranded copper conductors
2. Inner semi conductive layer
3. XLPE insulation
4. Outer semi conductive layer
5. Semi conductive tape
6. Copper screen
7. PP tape
8. HFFR outer sheath

DIMENSION AND WEIGHTS				ELECTRICAL PROPERTIES								
Nominal Cross Section	Overall Diameter (approx)	Net Weight (approx)	Delivery Length	DC Conductor Resistance at 20°C (Max)	DC Conductor Resistance at 90°C (Max)	Operation Inductance (approx)		Operational Capacitance (approx)	Current Carrying Capacity (A)			
									In ground at 20°C		In air at 30°C	
mm²	mm	kg/km	m	Ω/km	Ω/km	••• mH/km	•*• mH/km	μF/km	•••	•*•	•••	•*•
1x35/16	32,0	1200	1000	0,524	0,6707	0,680	0,451	0,123	214	192	233	202
1x50/16	33,5	1400	1000	0,387	0,4954	0,655	0,432	0,135	251	226	279	241
1x70/16	35,0	1650	1000	0,268	0,3430	0,624	0,408	0,151	306	276	348	299
1x95/16	37,0	1950	1000	0,193	0,2470	0,600	0,391	0,166	363	329	421	362
1x120/16	39,0	2250	1000	0,153	0,1958	0,581	0,377	0,180	410	373	483	416
1x150/25	40,5	2700	1000	0,124	0,1587	0,564	0,366	0,194	449	415	540	469
1x185/25	42,5	3050	1000	0,0991	0,1268	0,547	0,355	0,208	503	468	615	536
1x240/25	45,0	3650	1000	0,0754	0,0965	0,527	0,342	0,229	576	541	718	630
1x300/25	47,5	4300	1000	0,0601	0,0769	0,510	0,332	0,248	641	608	812	717
1x400/35	50,5	5450	500	0,0470	0,0602	0,489	0,320	0,276	697	684	904	823
1x500/35	54,0	6500	500	0,0366	0,0468	0,473	0,310	0,301	768	762	1011	929
1x630/35	57,5	7850	500	0,0283	0,0362	0,457	0,301	0,330	858	847	1128	1043

Prepared by:- Wshiar Hamarahim saeed

- Advantages:

- Superior conductivity: Copper has higher conductivity compared to aluminum, resulting in lower power losses and voltage drop over long distances.

- Excellent mechanical strength: Copper is generally stronger and more flexible than aluminum, making it more resilient to mechanical stress.

- Greater corrosion resistance: Copper offers better resistance to corrosion and oxidation, ensuring long-term reliability in various environments.

- Disadvantages:

- Higher cost: Copper is more expensive than aluminum, which can significantly impact project budgets, especially for large-scale installations.

- Heavier weight: Copper cables are heavier than aluminum cables, potentially increasing transportation and installation costs.

An idea to use Almuninum as a cable:-

The invention of aluminum cables began with the discovery of aluminum's conductivity and its challenging production process. Researchers experimented with aluminum's electrical properties, leading to the development of efficient production techniques like the Hall-Héroult process. As aluminum became more affordable, engineers explored its use in electrical wiring due to its conductivity and lightweight nature. They designed various cable configurations, conducted extensive testing, and refined manufacturing processes. Eventually, aluminum cables were commercially produced and adopted for electrical transmission and distribution, proving effective and cost-efficient for various applications, from power lines to building wiring. Today, aluminum cables remain a vital component of global electrical infrastructure.

Clyde Pellew, a Principal Electrical Engineer, highlights the historical significance of copper in electrical applications and the gradual shift towards exploring cheaper alternatives due to the rising demand and cost of copper. Copper's conductivity, durability, and reliability made it the material of choice for various electrical applications. However, with the escalating cost of copper, researchers and engineers began exploring alternative materials like aluminum. Despite aluminum's lower conductivity, advancements in cable design and manufacturing techniques have made it a viable substitute, particularly in power transmission and distribution systems. While aluminum cables offer significant cost savings, they also present unique challenges such as corrosion susceptibility and compatibility issues. Overall, the adoption of aluminum cables represents a pragmatic response to the need for cost-effective solutions in electrical engineering, requiring careful evaluation and engineering expertise to ensure optimal performance and reliability in diverse applications.

0,6/1 kV PVC insulated single core, aluminium conductor cables

Code: YAVV-U, YAVV-R, AL/PVC/PVC, NAYY

U: Solid Conductor
R: Stranded Conductor

Standards: IEC 60502-1, VDE 0276-603

Technical Data

Max. operating temperature	: 70°C
Max. short circuit temperature	: (max. 5 sec.)
Cross section ≤300 mm²	: 160°C
Cross section > 300 mm²	: 140°C
Rated voltage	: 0,6/1 kV
Min. bending radius	: 12 x D
D	: Cable outer diameter

Application

Indoor and outdoor applications, in cable ducts, underground, in power or switching stations, local energy distributions, industrial plants, where there is no risk of mechanical damage.

*** : RM or RE*

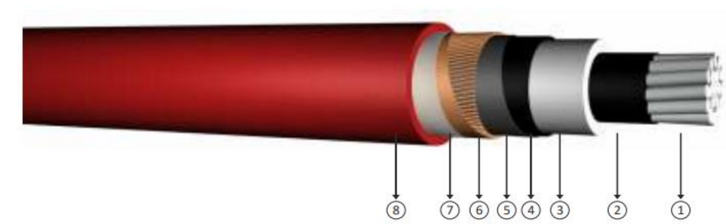
Construction

1. Stranded aluminium conductor
2. PVC insulation
3. PVC outer sheath

DIMENSION AND WEIGHTS				ELECTRICAL PROPERTIES				
Nominal Cross Section	Overall Diameter (approx)	Net Weight (approx)	Delivery Length	DC Conductor Resistance at 20°C Max	Current Carrying Capacity (A)			
					In ground at 20°C		In air at 30°C	
mm²	mm	kg/km	m	Ω/km	***	***	***	***
1x10**	8,5	100	1000	3,08	-	-	-	-
1x16**	9,5	130	1000	1,91	75	84	80	66
1x25	11,0	160	1000	1,20	125	105	87	75
1x35	11,9	200	1000	0,868	151	127	131	113
1x50	13,6	280	1000	0,641	179	151	160	138
1x70	15,2	350	1000	0,443	218	186	202	174
1x95	17,5	450	1000	0,320	261	223	249	210
1x120	19,0	550	1000	0,253	297	254	291	244
1x150	20,9	700	1000	0,206	332	285	333	281
1x185	23,3	800	1000	0,164	376	323	384	320
1x240	26,3	1050	1000	0,125	437	378	460	378
1x300	29,1	1300	1000	0,100	494	427	530	433
1x400	32,6	1700	1000	0,0778	572	496	642	523
1x500	36,1	2050	1000	0,0605	649	562	744	603
1x630	40,4	2600	500	0,0469	736	642	980	844
1x800	44,5	3200	500	0,0367	-	-	-	-

Prepared by:- Wshiar Hamarahim saeed

12/20 kV or 12,7/22 kV XLPE insulated, single core cables with aluminium conductor



Code: YAXC7V-R, NA2XSY, AL/XLPE/CWS/PVC

R: Stranded Conductor

Standards: IEC 60502-2,BS 7870-4.10

Technical Data

Max. operating temperature	: 90°C
Max. short circuit temperature	: 250°C (max. 5 sec.)
Rated voltage	: 12/20 kV 12,7/22 kV
Min. bending radius	: 15 x D
D	: Cable outer diameter

Application

These cables have a low dielectric loss, used in indoor and outdoor applications, in cable ducts, underground, in power or switching stations, local energy distributions, industrial plants, where there is no risk of mechanical damage.

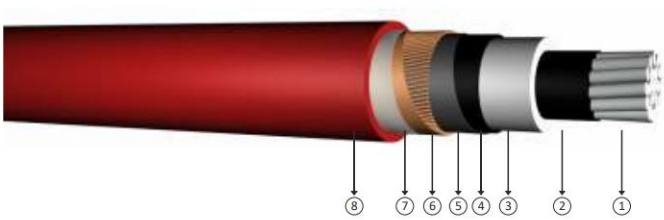
Construction

1. Stranded aluminium conductor
2. Inner semi conductive layer
3. XLPE insulation
4. Outer semi conductive layer
5. Semi conductive tape
6. Copper screen
7. PP tape
8. PVC outer sheath

DIMENSION AND WEIGHTS				ELECTRICAL PROPERTIES								
Nominal Cross Section	Overall Diameter (approx)	Net Weight (approx)	Delivery Length	DC Conductor Resistance at 20°C (Max)	DC Conductor Resistance at 90°C (Max)	Operation Inductance (approx)		Operation Capacitance (approx)	Current Carrying Capacity (A)			
									In ground at 20°C		In air at 30°C	
mm²	mm	kg/km	m	Ω/km	Ω/km	*** mH/km	*•* mH/km	µF/km	***	*•*	***	*•*
1x35/16	27,0	750	1000	0,868	1,1110	0,670	0,416	0,157	-	-	-	-
1x50/16	28,5	800	1000	0,641	0,8205	0,644	0,397	0,174	195	173	217	184
1x70/16	30,0	950	1000	0,443	0,5670	0,614	0,377	0,197	237	211	270	229
1x95/16	32,0	1050	1000	0,320	0,4096	0,590	0,360	0,218	282	252	328	278
1x120/16	34,0	1200	1000	0,253	0,3238	0,571	0,349	0,238	320	287	378	320
1x150/25	35,0	1400	1000	0,206	0,2637	0,554	0,338	0,258	353	320	425	363
1x185/25	37,0	1550	1000	0,164	0,2099	0,538	0,329	0,278	396	362	485	415
1x240/25	39,5	1800	1000	0,125	0,1600	0,518	0,317	0,308	457	421	573	493
1x300/25	42,0	2050	1000	0,100	0,1280	0,501	0,308	0,336	511	474	652	563
1x400/35	45,5	2550	1000	0,0778	0,1009	0,480	0,298	0,377	566	538	740	652
1x500/35	48,5	2900	1000	0,0605	0,0774	0,464	0,290	0,413	630	606	838	746
1x630/35	52,5	3400	1000	0,0469	0,0600	0,448	0,282	0,455	719	686	953	850

Prepared by:- Wshiar Hamarahim saeed

18/30 kV or 19/33 kV halogen free, flame retardant, XLPE insulated single core cables with aluminium conductor



Code: YAXC7Z1-R, NA2XSH, AL/XLPE/CWS/LSZH

R: Stranded Conductor

Standards: IEC 60502-2, BS 7835

Technical Data

Max. operating temperature	: 90°C
Max. short circuit temperature	: 250°C (max. 5 sec.)
Rated voltage	: 18/30 kV 19/33 kV
Min. bending radius	: 15 x D
D	: Cable outer diameter

Application

Used in energy networks in refineries, mines, hotels, schools, tunnels, high constructions, hospitals, power plant, data processing centers, business centers where there is a risk of fire.

Construction

1. Stranded aluminium conductor
2. Inner semi conductive layer
3. XLPE insulation
4. Outer semi conductive layer
5. Semi conductive tape
6. Copper screen
7. PP tape
8. LSZH outer sheath

DIMENSION AND WEIGHTS				ELECTRICAL PROPERTIES								
Nominal Cross Section	Overall Diameter (approx)	Net Weight (approx)	Delivery Length	DC Conductor Resistance at 20°C (Max)	DC Conductor Resistance at 90°C (Max)	Operation Inductance (approx)		Operation Capacitance (approx)	Current Carrying Capacity (A)			
									In ground at 20°C		In air at 30°C	
mm²	mm	kg/km	m	Ω/km	Ω/km	*** mH/km	$*^{*}*$ mH/km	µF/km	***	$*^{*}*$	***	$*^{*}*$
1x35/16	32,0	1000	1000	0,868	1,1110	0,680	0,451	0,123	-	-	-	-
1x50/16	33,5	1100	1000	0,641	0,8205	0,655	0,432	0,135	196	175	217	187
1x70/16	35,0	1200	1000	0,443	0,5670	0,624	0,408	0,151	238	214	270	232
1x95/16	37,0	1400	1000	0,320	0,4096	0,600	0,391	0,166	284	256	328	281
1x120/16	39,0	1500	1000	0,253	0,3238	0,581	0,377	0,180	322	290	378	323
1x150/25	40,5	1750	1000	0,206	0,2637	0,564	0,366	0,194	355	324	425	365
1x185/25	42,5	1900	1000	0,164	0,2099	0,547	0,355	0,208	400	366	485	418
1x240/25	45,0	2200	1000	0,125	0,1600	0,527	0,342	0,229	461	426	572	494
1x300/25	47,5	2450	1000	0,100	0,1280	0,510	0,332	0,248	516	479	649	564
1x400/35	50,5	3000	1000	0,0778	0,1009	0,489	0,320	0,276	572	545	737	654
1x500/35	54,0	3400	1000	0,0605	0,0774	0,473	0,310	0,301	638	614	835	747
1x630/35	57,5	3900	1000	0,0469	0,0600	0,457	0,301	0,330	728	690	950	851

- Advantages:

- Lower cost: Aluminum is more affordable than copper, making it a cost-effective option for many projects, particularly in medium-voltage applications.

- Lighter weight: Aluminum cables are lighter than copper cables, reducing transportation and installation expenses, especially for overhead transmission lines.

- Adequate conductivity: While not as conductive as copper, aluminum offers sufficient conductivity for medium-voltage transmission and distribution.

- Disadvantages:

- Higher resistance: Aluminum has higher resistance compared to copper, resulting in slightly higher power losses and voltage drop.

- Lower mechanical strength: Aluminum is generally less strong and more prone to deformation under mechanical stress compared to copper.

Compare between Copper cable with Aluminum cable:-

Certainly, let's compare copper and aluminum cables in detail, considering various factors such as conductivity, cost, weight, and electrical properties. We'll also include some example calculations to illustrate the differences between the two.

1. **Conductivity:**

- Copper has higher conductivity than aluminum. At room temperature, the conductivity of copper is approximately 58.5 × 10^6 S/m, whereas for aluminum, it's around 37.7 × 10^6 S/m. This means copper can transmit electricity more efficiently with less resistance.

2. **Cost:**

- Historically, copper has been more expensive than aluminum due to factors such as scarcity, extraction costs, and market demand. For instance, as of [2022](https://www.metalary.com/copper-price/), the price of copper is around $9,000 per metric ton, while aluminum is approximately $2,700 per metric ton.

3. **Weight:**

- Aluminum is lighter than copper. This weight difference can be significant, especially in applications where weight is a concern, such as aerial power lines.

4. **Electrical Properties:**

- Aluminum has a higher resistance compared to copper. This means that for the same length and diameter, an aluminum wire will have higher resistance and, therefore, more power loss (I^2R loss) compared to copper.

- However, aluminum has a lower thermal expansion coefficient than copper, which can be advantageous in certain applications where temperature changes are a concern.

DIMENSION AND WEIGHTS				ELECTRICAL PROPERTIES								
Nominal Cross Section	Overall Diameter (approx)	Net Weight (approx)	Delivery Length	DC Conductor Resistance at 20°C (Max)	DC Conductor Resistance at 90°C (Max)	Operation Inductance (approx)		Operational Capacitance (approx)	Current Carrying Capacity (A)			
									In ground at 20°C		In air at 30°C	
mm²	mm	kg/km	m	Ω/km	Ω/km	*** mH/km	∴ mH/km	μF/km	***	∴	***	∴
1x95/16	37,0	1950	1000	0,193	0,2470	0,600	0,391	0,166	363	329	421	362
1x95/16	37,0	1400	1000	0,320	0,4096	0,600	0,391	0,166	284	256	328	281

Properties	Unit	Aluminum	Copper
Specific Gravity	g /cm³	2,70	8,96
Melting Temperature	°C	660.32	1084,62
Heat Conductivity	W / (m.K)	237	401
Coefficient of thermal expansion (25°C)	μm / (m.K)	23.1	16.5
Elasticity Module	kN / mm²	70	120
Resistance heat exchange coefficient at 20°C	1 / °C	0,0040	0,0039
Conductivity in 20°C	IACS %	61...62	97...100
Specific resistance at 20°C	nΩ . m	26,50	16,78
Tensile Stress (hard-annealed)	kg / mm²	180...80	450...240
Elongation at break (hard-annealed)	%	2...35	1...35

- Basic Specifications Table -

Prepared by:- Wshiar Hamarahim saeed

Dose copper stronger than aluminum for mechanical load?

Yes, copper is generally stronger than aluminum when it comes to mechanical loads. Here's an explanation:

1. **Material Properties:**

- Copper has higher tensile strength and greater ductility compared to aluminum. Tensile strength refers to the maximum amount of tensile (pulling) stress a material can withstand before breaking, while ductility is the ability of a material to deform without fracturing.

- Due to its higher tensile strength, copper cables are less likely to deform or break when subjected to mechanical loads such as bending, twisting, or stretching.

2. **Flexibility:**

- Copper cables are typically more flexible than aluminum cables, allowing them to withstand repeated bending or flexing without sustaining damage. This flexibility makes copper cables more resilient in applications where cables may be routed through tight spaces or subjected to frequent movement.

3. **Fatigue Resistance:**

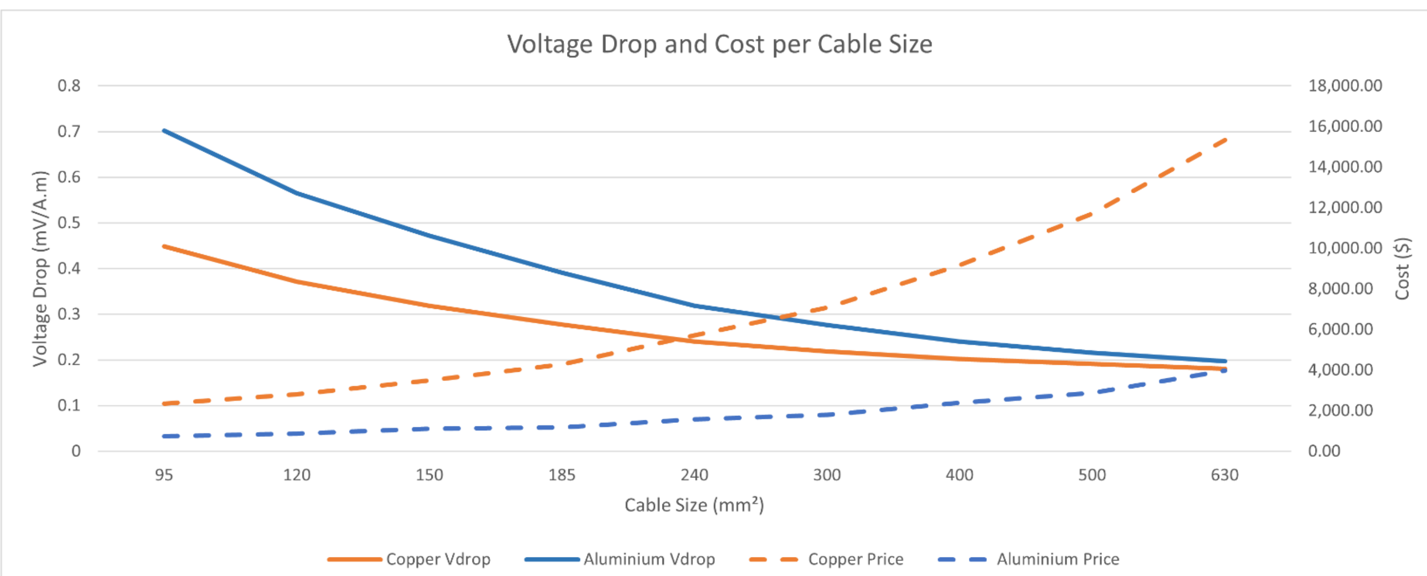
- Copper exhibits better fatigue resistance than aluminum, meaning it can withstand repeated cycles of stress without weakening or failing over time. This property is particularly important in applications where cables are subjected to dynamic loads or vibration, such as in moving machinery or vehicles.

4. **Creep Resistance:**

- Copper has superior creep resistance compared to aluminum, which refers to the tendency of a material to slowly deform or "creep" under constant stress over time. This resistance to creep deformation makes copper cables more suitable for applications where long-term mechanical stability is critical, such as in structural components or high-temperature environments.

5. **Corrosion Resistance:**

- Copper also offers better resistance to corrosion and oxidation compared to aluminum. Corrosion can weaken the structural integrity of cables and accelerate mechanical failure, so the superior corrosion resistance of copper contributes to its overall mechanical strength and durability.



Prepared by:- Wshiar Hamarahim saeed

Conclusion

cables are essential components of modern infrastructure, enabling the transmission of energy, signals, and data across various applications. They consist of conductors encased within insulating materials, providing pathways for electrical currents or optical signals while shielding against interference and environmental factors. Cables are utilized extensively in telecommunications, electricity distribution, networking, and transportation systems, evolving to meet the escalating demands for faster speeds, increased bandwidth, and heightened reliability.

Copper cables, with their superior conductivity, flexibility, and durability, have been instrumental in various applications since the early 19th century. Initially developed for telegraphy, copper cables have expanded to include telephone lines, power distribution, and data transmission. They are used across a wide range of voltage systems, from low to medium voltage, where their conductivity and resistance to corrosion make them ideal for efficient signal transmission.

The introduction of aluminum cables represented a shift towards exploring cheaper alternatives to copper due to rising costs and demands. Although aluminum has lower conductivity and higher resistance compared to copper, advancements in design and manufacturing have made aluminum cables viable substitutes, particularly in medium-voltage applications. Aluminum's lighter weight and lower cost make it preferred for overhead transmission lines, where cost efficiency and weight reduction are significant factors.

Overall, the choice between copper and aluminum cables depends on various factors such as conductivity, cost, weight, and specific application requirements. While copper offers superior conductivity and mechanical strength, aluminum provides cost-effective solutions, especially for medium-voltage transmission and distribution systems. Both materials play crucial roles in modern infrastructure, ensuring the seamless exchange of information and power essential for contemporary society.

References

IEEE Standards

National Electrical Code (NEC)

Anixter.com

Government Publications

Trade Magazines

ZMS.com

C lyde Pellew, Principal Electrical Engineer

Engnerringmidset.com

DMA engineers.com

Enerji_katalog_en/Hes kablo