APPLICATION ORIENTED DESIGN OF CABLES

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Abstract -Electricity distribution is the final stage in the distribution of electricity to end users. Cables remain a singular mainstay ofpower transmission and distribution. Designs discussed here are based on Gulf region utility requirements; however the same is applicable for all the similar designs and constructions of the cables. Following Five (5) designs are discussed with their incentives and pain areas; all are in Medium voltage range and are with three (3) cores constructions with similar system requirements.

1) Copper conductor, steel wires armoured with Tinned copper insertion and PVC sheathed.
2) Copper conductor, Individual core longitudinal and radial watertight with Poly- aluminium construction, wire armoured, PVC bedding, Polyethylene sheathed.
3) Copper Conductor, water tight conductor with earth conductors in interstices, steel tapes armoured and Polyethylene sheathed.
4) Cable longitudinal and radial watertight, Lead sheathed, un-armoured, Polyethylene sheathed.
5) Copper conductor, non water tight construction, without individual core
Screen , Armour acts as low resistance earth return conductor, PVC sheath

Keywords – MV XLPE cables, cable design, water tight cable design, and cable screen design.

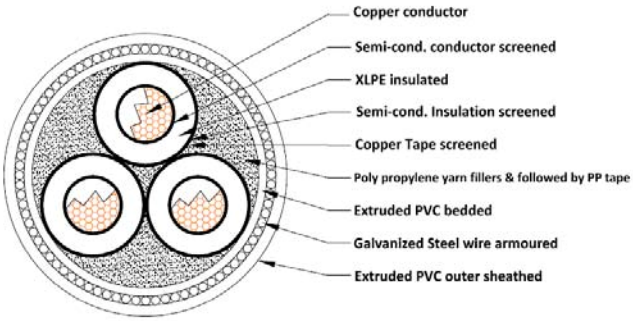
Introduction –Shielded, medium voltage (MV) power cables (6kV to 33kV) has long been considered a commodity product, with little differentiation seen between competing product offerings. Yes, the basic construction of this type of cable, as well as its physical and electrical performance properties are very similar from one make to another. However, you have a choice of insulations, metallic shields, and jackets, all of which depend on the specific power system requirements, installation rigors, service conditions, and/or environmental factors.of thermal rating of 90 deg C max. and Voltage rating of 11 kV. Although the electrical requirements are same, due to different constructional components, the advantages and limitations changes .The detail study done and expressed here will be useful while selecting the cable in their application.

More importantly, you should realize that the shielded Type MV power cable is a more complex and sophisticated product than it's usually given credit for. It is manufactured to meet stringent engineering standards and requires special attention in terms of proper handling and installation. Considering the widespread use of this type of cable in primary feeders in a wide range of large complexes and facilities as well as in utility applications, we think it's time that you take a fresh look at Type MV power cable fundamentals. We believe it will be both timely and extremely useful.
Basically power cables have two ratings, thermal and voltage rating. Cables under consideration are

Two radial and longitudinal water blocking designs, two non water blocking and one
Conductor water blocking design is discussed here.
The aim is, with different components in cables, adverse site and local effect can be nullified.
In Europe Lead is banned, but as a radial water blocking design it is still in use in many part of the world. It is argued that, underground application of lead does not present a significant risk to human health and the environment, because transport of lead to soil is limited due to presence of polymer jacket which is usually provided on top of lead sheath.

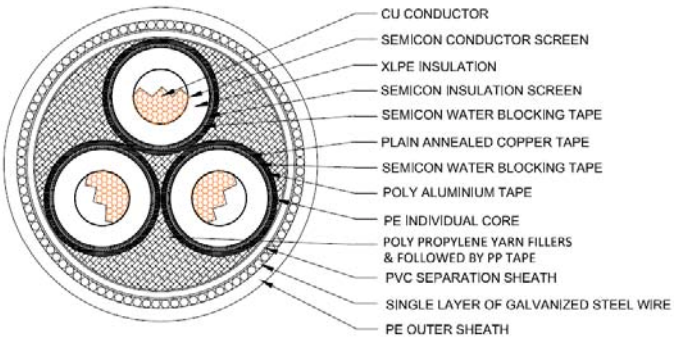
Let us discuss one by one design …

DESIGN TYPE 1 –Standard Cable (fig 1)
Cable is as per IEC / BS Standards



- **Electrical** -SC withstanding of 3 cores copper screen and armour together is 23.21 kA for a second.
- **Tinned copper insertion** can increase the SCrating equivalent to power conductor SC rating
- **Environment** – Non water tight construction
- **Mechnical** –Armouring of SWA can withstand better tensile and crushing forces.
- Damage resistant, robust.
- PVC sheath provides Fire retardant property.

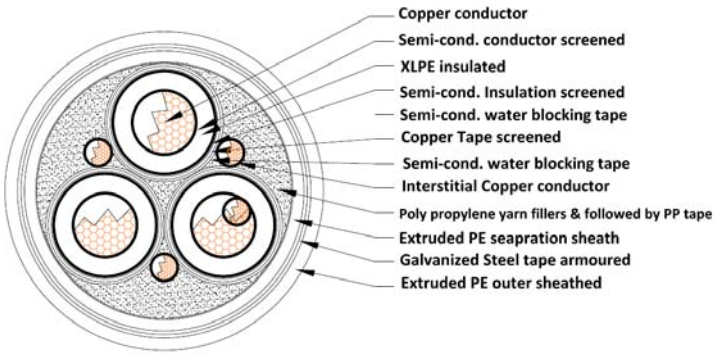
DESIGN TYPE 2 –Radially and longitudinally water tight cable
(Fig.2)



Cable is as per Utility standards; construction is unique and not defined in any international standard.

- **Electrical** -SC withstanding of 3 cores copper screen and armour together is 25.14 kA for a second.
- **Environment** -Radial and longitudinally water tight at each core stage.
- **Installation** - Diameter is very high and so the number of processes in the production.
- **Mechanical** - Armouring of SWA can withstand better tensile and crushing forces.
- PVC Bedding and PE sheathing nullifies each others advantages and hence not recommended.
- Technically superior water tight cable design for 3 core construction without lead sheath.

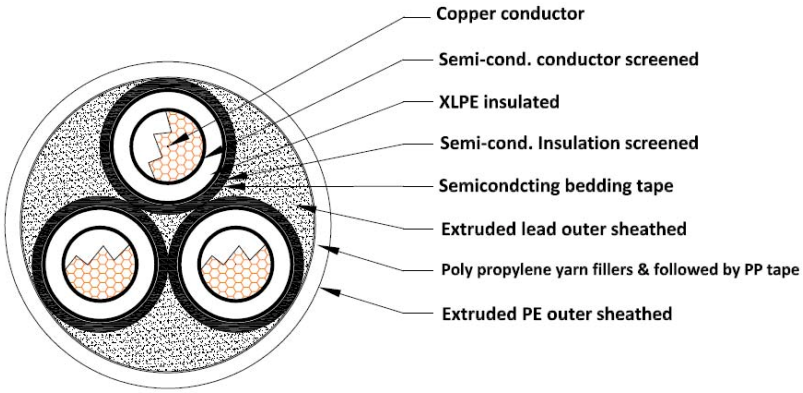
DESIGN TYPE 3 (Fig.3) –Water tight at conductor level with interstitial copper conductors



Cable is as per Utility standards; no other international standard specifies such design.

- **Electrical** -SC withstanding of 3 cores copper screen and interstices conductor together is 21.84 kA for a second.
- **Environmental** - Longitudinally water tight; But not radially.
- **Cost** -Copper content is highest and so costly.
- **Installation** –with steel tape armour mechanical strength is limited but compensated by PE sheathing.
- Inherently termite proof due to PE sheath

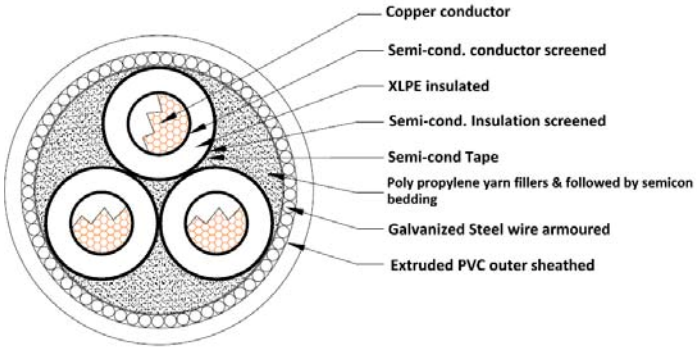
DESIGN TYPE 4 –Lead sheathed Radial and longitudinal water tight cable (Fig.4)



Cable is as per Utility standards; basis is old SL type Paper cable and so proven design.

- **Electrical** -SC withstanding of lead sheath is 18.74 kA for a second.
  can be increased by increasing lead thickness
- **Environmental** -Radial and Longitudinally water tight.
- Suitable for soil where in Oil and Hydrocarbon present.
- **Cost** - Copper content is lowest
- **Mechanical** – Un armoured cable and so mechanically weak
- **Installation** - Heavy in weight special installation practices may be required

DESIGN TYPE 5 (Fig.5) Without Individual Screen; Non water tight cable



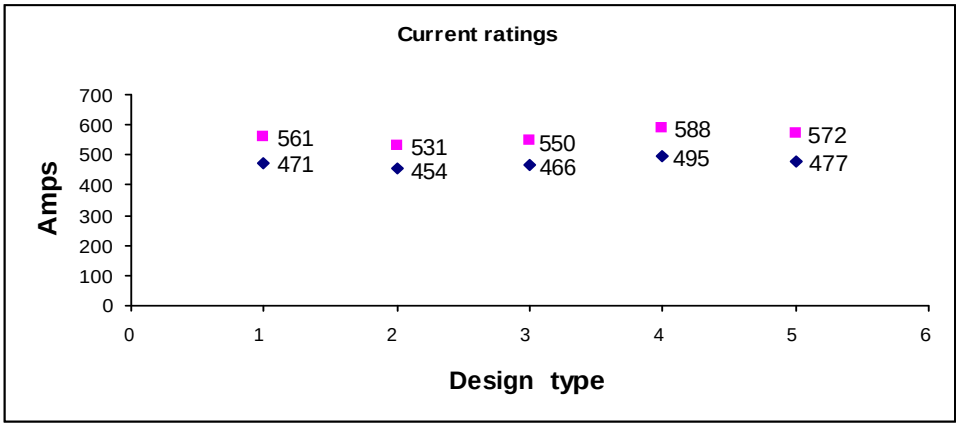
Cable is as per Utility standards; without individual copper screen on cores

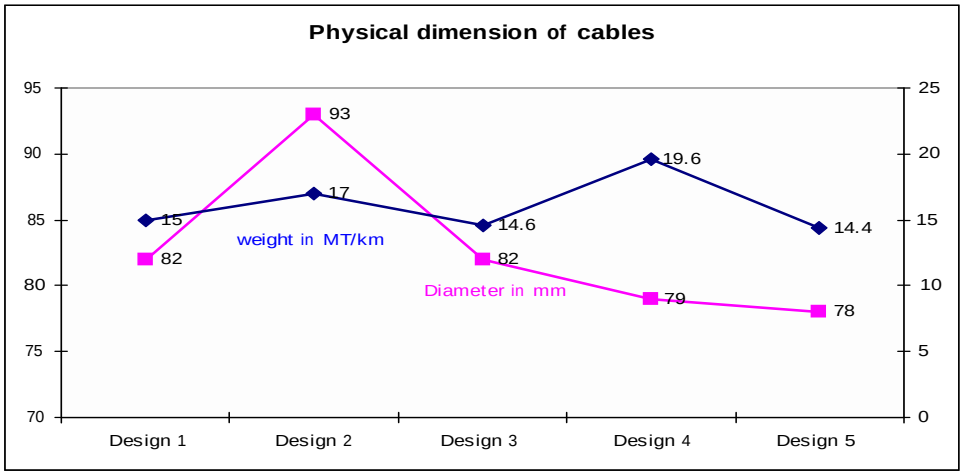
- **Environment** -Non water blocking construction
- **Cost** -Copper content is lowest

All the cables with Polyethylene sheath may be with semi-conducting extruded layer over the sheath. Semi-conducting jacket provides good grounding that significantly reduces the magnitude of any surge voltage impressed on the

- **Mechanical** - Armouring of SWA can withstand better tensile and crushing forces
- **Installation** - Least in dimensions and weight cable. Semi-conducting jacket provides similar grounding characteristics to bare concentric neutral and the moisture retardation of insulating jacket. PVC sheathed also may be with Graphite layer as semi-conductive layer.
- **Electrical** - SC withstanding of Armour is 18.64 kA for a second.

Dimensions and Current ratings of individual construction is as shown in below graphs





A wide choice of cable types exist to suit different situations. Wherever possible the cable construction should be designed to suit the thermo-mechanical requirements of the cable system to achieve maximum circuit reliability. Cable manufacturers and Utilities must together decide to get right design for right application.

To conclude on the designs and their advantages over different conditions in the field, following tabulation can be useful .

Characteristics	**Design 1**	**Design 2**	**Design 3**	**Design 4**	**Design 5**
	Standard Armoured, PVC	Individual core WT PVC/SWA/P	Separate Earth conductors	Individual core Lead sheath/PE	Armour as Earth return
	sheathed	E	PE/STA/PE		/PVC
Continuous electrical load	G	G	G	E	G
Short Circuit load	E	E	F	G	E
Bending properties (flexing property)	G	F	G	P	E
Anti Termite and Rodent, Reduced water diffusion, higher abrasion resistance and increased toughness.	G	E	E	E	G
Water Resistant	F	E	G	E	F
Joint and Accessories	Standard	Special	Special	Standard	Standard

E-Excellent; G –Good; F –Fair; P-Poor

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