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Socketing procedures for wire ropes — Resin socketing

0 Introduction

Sockets are the most efficient of wire rope terminations and if properly made will sustain the full breaking load of the rope. Traditionally the socketing material has been molten white metal or zinc. More recently, however, suitable synthetic resins have been developed.

The first laboratory tests on resin socketing were carried out about twenty years ago in both Europe and America. They showed that man-made resins could satisfactorily hold the rope under both static and dynamic loads.

There has been considerable development since then, and in some areas, notably the testing of wire ropes, the use of resin socketing has become widespread.

The two resins systems currently in general use are based respectively on polyester resins and epoxide resins. In general, the polyester is slightly more brittle than the epoxide, but is less temperature sensitive in the curing stage. In addition, the polyesters cure much more quickly than the epoxides.

In neither system, however, is it necessary to pre-heat the socket prior to pouring and the temperature of the resin during pouring and curing is much lower than the normal casting temperatures for metal. There is therefore less possibility of the heat affecting either the lubricant or wires in the rope. This is especially an advantage when socketing higher tensile ropes.

Field experience has developed, or is developing, in a number of countries, notably in the United Kingdom and the Netherlands with polyesters, and in the USA with epoxides. A system study of polyester resin socketing has been carried out by government laboratories and commercial companies in the United Kingdom.

Whilst the laboratory tests and investigations have shown the current resin systems to be satisfactory, practical experience is somewhat limited; in view of this, ISO Technical Committee 111 has recommended the publishing of this document in the form of a Technical Report rather than an International Standard at this stage in order to draw the attention of the experts to this type of socketing and gather more experience. It is envisaged that with the more widespread usage of resin socketing, it will be possible to elaborate, in due course, an International Standard on the basis of this Technical Report.

NOTE — Sockets and molten metal socketing will form the subject of future International Standards.

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1 Scope and field of application

This Technical Report provides guidance on recommended practices for the resin socketing of wire ropes produced in accordance with ISO 2408. The recommendations are also generally applicable to the socketing of other wire ropes.

When socketing ropes which have wire tensile grades greater than 1 960 MPa (N/mm^2), special precautions may be necessary and the rope supplier should be consulted.

Rope terminations made by socketing in accordance with this Technical Report may be used for determining the breaking load of wire ropes in accordance with ISO 3108.

2 References

ISO 2408, *Steel wire ropes for general purposes — Characteristics.*

ISO 3108, *Steel wire ropes for general purposes — Determination of actual breaking load.*

ISO 3189/1, *Sockets for wire ropes — Part 1 : General conditions of acceptance.*[1]

3 General

ISO 3189/1 specifies the dimensions of the sockets for general purpose ropes. The sockets and socketed assemblies shall pass the prototype tests indicated in the same International Standard.

Sockets for use with spiral strands and locked coil ropes, and for carrying out breaking load tests on ropes may have special dimensional requirements.

4 Preparation of the rope end

A sufficient length of the rope should be externally cleaned on both sides of the designated point of cut by wiping with a clean dry cloth. This cleaning should be confined to the length of rope to be threaded through the socket.

4.1 Seizing of the rope

Two types of seizing are recognized.

a) Temporary seizing is used when cutting non-preformed ropes, multistrand ropes, spiral strands, etc. A temporary seizing may be applied to the rope on each side of the cut.

These seizings should be such as to hold the strands and wires reasonably well in position during the cutting operation.

b) Permanent seizing is used to hold the wires and strands during the socketing operation. A permanent seizing is applied to that part of the rope which is partly within or adjacent to the mouth of the socket or immediately outside the socket when the operation is completed.

The permanent seizing should

1) ensure that the wires and strands are undisturbed during socketing operations;

2) permit the passage of the seized rope through the mouth of the socket.

4.2 Seizing material

The seizing material should be tinned or galvanized soft wire or strand for galvanized rope, and bright or galvanized soft wire or strand for bright rope.

Alternative materials may be used but care should be taken that they do not cause deleterious electrolytic action in service.

1) At present at the stage of draft.

Copper and brass wires should not be used for seizings. Plastic seizings of proved suitability may be allowed.

4.3 Cutting the rope

The rope should be cut by any suitable method which does not disturb the position of the wires below the permanent seizing. Cutting with an abrasive wheel is to be preferred. When cutting by percussive or shearing methods special care is required. Oxyacetylene cutting should not be employed owing to the risk of heat damage to the wires and lubrication, and to the difficulties of separating the wires during subsequent socketing operations.

5 Preparation of the brush

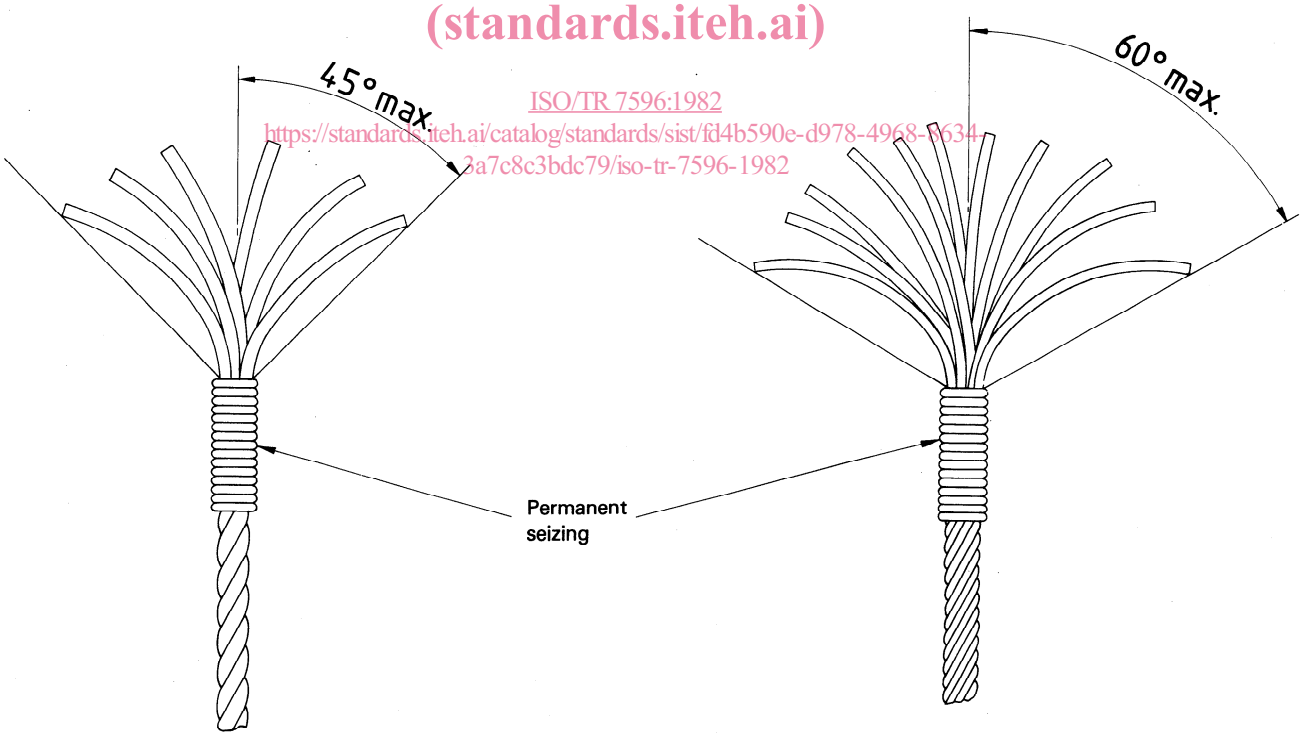
5.1 Preparation of the rope

Before threading the socket on to the rope, all dirt, grease or scale should be removed from the inside of the basket.

The cut end of the rope should be threaded through the socket taking care that the basket walls do not come into contact with the uncleaned part of the rope. If this does occur, the rope should be unthreaded and the socket walls recleaned. After threading, the temporary seizing at the point of cut should be removed and the strands unlaid as far as the permanent seizing, and swept outwards to allow opening of the wires.

The opening angle of the final brush should not exceed 45° from the vertical for stranded ropes [see figure 1a)].

For locked coil ropes and spiral strands the wires should be unlaid and swept outwards at an angle not exceeding 60° from the vertical [see figure 1b)].



a) Stranded ropes

b) Locked coil ropes and spiral strands

Figure 1 — Opening angle of the brush

When a rope contains a steel core, the wires of the core should be completely unlaid to form an open brush.

When a rope contains a fibre core, the core should be cut and removed down to the permanent seizing.

After dealing with the core the individual wires from the strands should be unlaid (but not straightened) and a brush formed.

Care should be taken not to bend the wires or the strands to an excessive angle at the permanent seizing, since this may cause premature fatigue failure in the completed assembly.

5.2 Cleaning and degreasing

The open brush should be thoroughly cleaned and degreased, with either an approved organic solvent, or an emulsion type cleaner. Hot degreasing solutions are preferred.

Petrol, paraffin and similar materials are not recommended.

When using liquid degreasing agents, the brush should be held downward to prevent the degreasing fluid, or water, being trapped in the throat of the brush. The degreasing process may be accelerated by use of an ultrasonic device.

The degreasing agent should be liberally used and worked well into the throat of the brush.

If water-based cleaning agents are used, the residues should be completely removed by washing off in water.

When using a vapour degreasing method, the brush should be held inserted in the vapour until all the grease and dirt has been removed. Care must be taken to ensure that the rope above the serving is not immersed in the vapour.

CAUTION : During the cleaning and degreasing operations, the following precautions shall be taken.

a) Great care must be taken that degreasing is confined to the brush, and does not affect the rope beyond the brush.

b) When using water-based cleaning agents, it is essential to ensure that the agent is completely removed, and that the brush is dried quickly.

c) In all cases the time between cleaning and pouring the socketing resin should be as short as possible to minimize oxidation and corrosion of the rope.

d) Chlorinated hydrocarbons and other toxic or flammable organic solvents shall only be used in areas designed for the purpose, or in an extremely well ventilated environment.

5.3 Hooking

Hooking of wires (i.e. turning over the wire ends without a sharp radius) is recommended for 6 × 7 and similar coarse construction ropes especially where there is the possibility of shock loading.

Hooking of wires for other constructions is not normally necessary.

6 Positioning and alignment of brush, rope and socket

A seizing wire shall be placed around the brush near its top end to draw the brush slightly together to form a shape approximating to, but slightly smaller than, the shape of the socket basket, to prevent an appreciable length of the outermost wires from bearing against the wall of the socket when the socket is positioned over the brush.

The socket basket should be drawn over the brush until the ends of the wires, or the bends in the hooked wires, are 1 to 2 mm above the basket of the socket. Alternatively, the wire ends may be slightly below the top of the socket, but in these cases the rope just below the mouth of the socket should be marked to indicate any movement during subsequent operations.

The wires should be evenly distributed as far as possible at the top of the socket basket.

Following the positioning of the brush, the rope should be clamped to a suitable support and the axes of the rope and socket aligned. The rope below the socket should be straight for at least 30 diameters, after which the rope may be allowed to bend but with a radius of at least 50 rope diameters.

The neck of the socket should then be sealed with yarn, fibre or flexible putty or clay (the latter being especially useful in the case of large open-lay ropes) to prevent the passage of resin. Care should be taken to ensure that the sealing material is not pushed into the gap between the socket and rope. If this occurs it will prevent penetration of the resin through to the socket mouth, which could lead to corrosion and premature fatigue failure in service.

7 Preparation and pouring of socketing resin

The resin should be mixed and poured in accordance with the manufacturer's or sponsor's instructions. In all cases the resin should be poured close to the side of the socket.

Any entrapped air may be removed by stirring the resin with a single wire.

Should the initial mix of resin be insufficient to fill the socket, or, in the case of large sockets should any shrinkage occur, it is important that the manufacturer's or sponsor's instructions regarding topping up procedures be followed carefully.

After pouring, the resin must be allowed to harden before any attempt is made to move the rope or socket.

The hardness of the material can be ascertained by checking any residual material in the mixing vessel or, simply, by scratching the surface of the resin in the socket with a piece of sharp metal.

When the resin has hardened, the seizing should be removed up to the mouth of the socket to facilitate inspection.

A suitable corrosion preventive compound should be applied to the cleaned length of the rope taking care to cover all exposed wires and to seal the mouth of the socket.

8 Socketing resins

For guidance some examples of commonly used socketing resins are indicated in the annex.

Manufacturer or sponsor instructions should always be consulted before use and care should be taken not to exceed the recommended shelf life of the material.

Resin socketing offered for use shall have passed the prototype test on the socketed assembly, as specified in ISO 3189/1.

The sponsor or manufacturer should provide adequate information on the resin socketing system.

NOTE — Resin socketing is a relatively new technique and evidence on stability over an extended period is limited. Therefore caution should be exercised when using resin socketing in installations which have a long life (say over four years).

Resins are more temperature sensitive than the socketing metals. In view of this the sponsor or manufacturer should be consulted if the temperature in use is likely to exceed 70 °C.

9 Quality control

The quality of the socketing may be assessed in one of the following ways.

a) By removing the cone after solidification, and visually inspecting it to ensure that it is satisfactory. If this method is used, care should be taken to ensure that the orientation of the cone in the socket is the same before and after inspection. This may be achieved by setting a mark.

b) By visual inspection to ensure that the socket resin has completely filled the annulus between the rope and the socket mouth, and that the socket is properly filled with socketing material.

c) By proof loading to 40 % of the minimum specified breaking load of the rope, after which the rope shall not have moved out of the mouth of the socket by more than 2 % of the basket length.

Annex

Examples of commonly used socketing resins

A.1 Epoxide resins

Epoxide resins are normally cured by amines or polyamides. The proportion of resin to hardener is critical and the manufacturer's or sponsor's instructions should be followed exactly.

The usable or pot life is dependent upon the system in use and also upon the temperature.

A.2 Polyester resins

These consist of various polyester/styrene solutions which are cured by the addition of organic peroxides. The amounts of catalyst to be used should not exceed 4 % by weight, nor be less than 1 %.

The usable or pot life depends upon the amounts of catalyst used and upon the temperature.

A.3 Fillers

Inert fillers are permissible and in the case of polyesters, they are recommended. It is important to follow the manufacturer's or sponsor's instructions.

CAUTION — Resins may cause irritation of the skin and care shall be taken to ensure that they do not come in contact with bare skin.

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