



Safety Precautions for Pre-stressing Operations

Introduction

It is important to consider the failure modes that may occur during the stressing operation. The strands of wire can be released due to the wire breaking at butt welds, at kinks in the wire, at damage points in the wire, failure of a double joiner, failure of wedges or barrels, failure of the anchorage points etc. The released wire moves at a very fast rate and can inflict serious or fatal injuries. When the steel wire anchorage fails the wire can shoot through the hydraulic jack into the protected area where the stressing operations are carried out. This may result in a direct hit on the stressing operator or depending on the lay-out the wire can ricochet off the back wall of the structure and hit the stressing operator.

Written **SAFE OPERATING PROCEDURES** for the stressing operation must be prepared and strictly implemented. Roles of individuals involved in the process should be defined in these procedures.

Only **trained** and **competent** personnel who are **authorised** should operate the stressing equipment. Review the training provided to all Operatives and ensure they are provided with appropriate personal protective equipment.

Precautions during stressing operations

Personnel not directly involved in the stressing operation must be excluded from the work area. Warning signs and an audible and visual (flashing light) alarm will alert personnel that stressing is taking place. No one should be working on the beds during stressing or on adjacent beds – everyone must be behind a guard or in another safe location.

The stressing operator must adopt a system of work that ensures they are never directly behind the hydraulic jack.

Operators must be provided with written instructions detailing the size of the strand and the appropriate stressing force or tension to be used for the strand. The instructions may also include the equivalent reading on the pressure gauge of the pump unit. This information should be recorded and records maintained.

Review the layout of the stressing area

Carry out a review of the stressing area to ensure that all the failure modes are considered and protection provided. This exercise may require modifications to be carried out such as providing a timber liner to capture any wires that travel through the hydraulic jacks. When the stressing operation is complete the wires at the stressing end must be guarded.

It is recommended that spring loaded grips are used at the anchorage end of the stressing bed.



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Do not's

Welding or hot works must not be carried out on or anywhere near steel wires. Heat will change mechanical properties of steel wire and promote the possibility of premature failure. The damage caused by inadvertent heating will not be detected during a visual inspection.

Do not use an acetylene torch to cut to length or to trim steel wire before stressing since the heat affected zone will extend several centimetres from the cut and the jack jaws may grip the mechanically weakened area. Use snips or an abrasive wheel.

Do not use hand held grinders to cut bands or packaging around full wire drums. Hand cutters should be used.

Coils of wire must be lifted using a nylon sling and not lifted directly using lifting chains.

Use of Intermediate Saddles

Intermediate saddles must be placed over the stressing bed area at regular intervals (every 10 metres) to contain the steel wire in event of failure. These may be safety chains secured to floor anchor points.

A daily visual inspection of the anchorage points for the safety chains, saddles and anchorage bars at the ends of the beds should be completed by the stressing operator.

Guarding

Provide suitable and sufficient protection so in the event of wire failure during stressing operations the operator is safe.

Guarding of the wires after they are stressed at the stressing end can be achieved by either using a pipe to cover each wire or construct a box guard as illustrated in the picture to cover the stressed wires.





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Permanent Anchorage Points

The permanent anchorage points at both ends of the stressing bed should be cleaned and examined every five years to ensure their integrity using a non-destructive testing (NDT) process e.g. ultrasonic, magnetic particle or dye penetrant by a trained NDT engineer. The NDT engineer should draw up an inspection schedule including the cleaning which is necessary to permit adequate examination. Records of the examination must be kept for 10 years.

Hydraulic jacks

Routine inspection and maintenance of each hydraulic jack (as recommended by the manufacturer), including the clamping jaws inside the jack, must be completed by an authorised competent person who has been appropriately trained. Clamping jaws inside the jack must be replaced at intervals specified by the manufacturer.

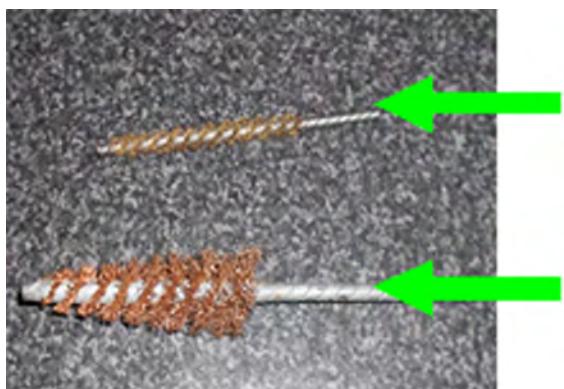
All hydraulic jacks must have a current calibration certificate (every six months). The calibration certificate is only valid if the same jack is used with the same hydraulic pump as used during calibration.

The pressure relief valve on the hydraulic pump may need to be adjusted to the appropriate pressure for the type of stressing jack and in particular the size of strand being tensioned. Guidance should be sought from the manufacturer of the hydraulic stressing pump. If the relief valve is not correctly set it may be possible to over tension the wire.

Cleaning

Barrels and wedges in poor condition may lead to slipping failure under load.

ALL BARRELS AND WEDGES MUST BE THOROUGHLY CLEANED, EXAMINED and LUBRICATED AFTER EACH USE. Manufacturers can make recommendations for appropriate cleaning methods. Depending on the cleaning system the barrels and wedges may need to be dried and treated with corrosion protection prior to lubricating.



Wedge cleaning brush

Barrel cleaning brush



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Inspection

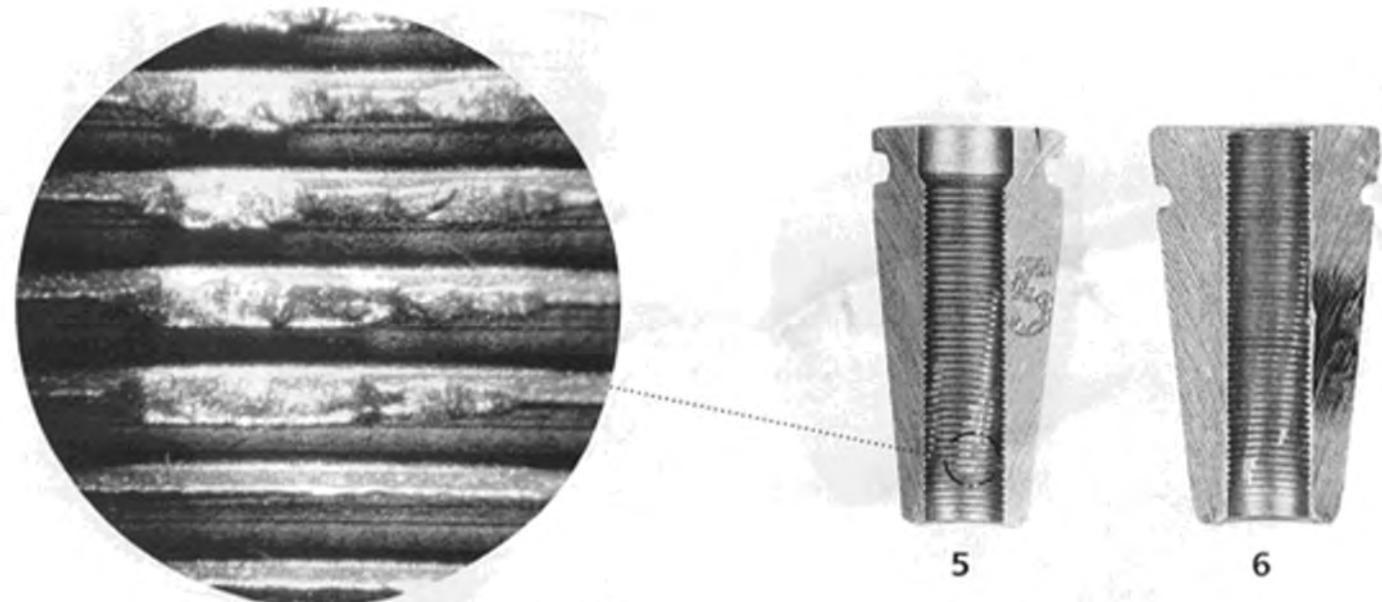
The inspection of wedges and barrels should be carried out in an area away from the production environment. Where possible the inspections should be carried out by a person not involved in the production process. Inspection of the wedges and barrels must be carried out in good light with the aid of a magnifying glass.

These inspections may require the use of more sophisticated equipment (see the example of a Magnifier with reference lines at the end of this document) or a microscope. Rejected items must be removed from the production process immediately.

An independent inspection by a third party of wedges and barrels should be carried out every 12 months.

Management should carry out spot checks on the implementation of the safe operating procedures.

What to look for when inspecting wedges and barrels



Above is an example of wedges where teeth are damaged. The strand has slipped causing a gouge diagonally across the teeth. These wedges must be replaced.

When inspecting the wedges look for worn teeth ie the points of the teeth have been flattened beyond a tolerance which is specified by the manufacturer. For example one such specification identifies 0.2 - 0.3mm for the maximum width of the flat on the top of the tooth where the pitch (distance between the teeth) is 1mm. This tolerance is not applicable to all wedges – **always check with the manufacturer.**



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Flattening of the teeth is important for two reasons. Firstly the teeth are intended to bite into the wire to achieve a grip; flattening of the teeth reduces the effectiveness of the grip. Secondly, the teeth are case hardened to improve the wear resistance of the wedge grip. With use, the hardened case gradually wears and when it is worn through, the softer core will be exposed to the wire and may wear more quickly. Any wedges that are showing signs of significant wear must be taken out of service.

Broken teeth and/or any cracks would be reason to discard the wedge. Barrels should also be examined for signs of wear, cracks or distortion especially in the inner taper.

Operators should only use wedges and barrels in good condition. Any suspect wedges or barrels should be set aside for further examination or discarded straight away. This will require a system of segregation.

Put a rotation system in place to guarantee even use of the barrels and wedges.

Barrel and wedges must be used in sets provided by the same manufacturer and must not be mixed.

IF IN DOUBT DO NOT USE THE WEDGE OR BARREL



Magnifying glass and light



Wedge & Barrel carousal

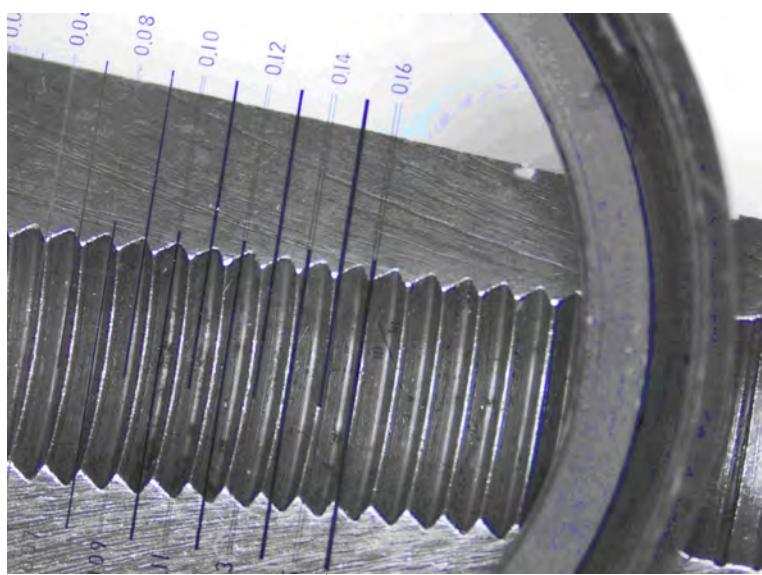
Example of the use of a Magnifier with an attachment setting out reference lines (as seen below) so as to identify wear on the top of the teeth in excess of 0.16mm. This equipment can be purchased for around £60. The magnifier in the picture below is fitted with a transparent grid of reference lines up to 0.16mm. When viewed through the magnifier the lines can be superimposed on the teeth of a wedge so as to estimate any area worn flat.



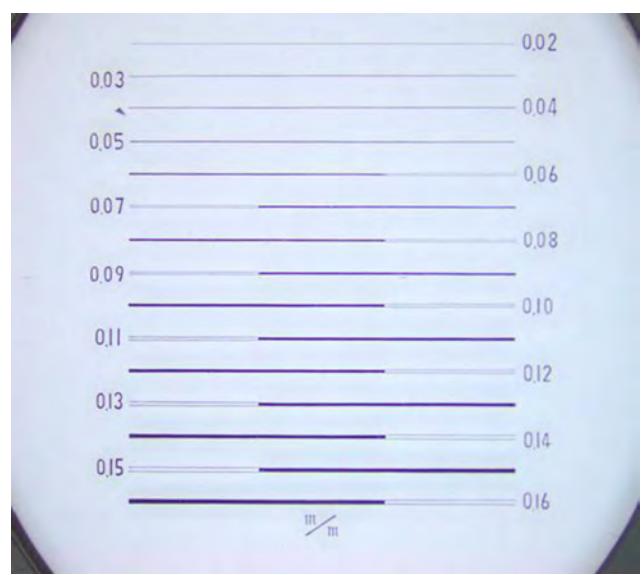
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Magnifier and wedge



0.16mm line over a good tooth



Reference lines visible through magnifier