EFRC Training Workshop

Foundation Design for Reciprocating Compressors

Installation, Operation and Maintenance

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Introduction

When the compressor is dispatched from the workshop it is practically "barefooted".

At site the "shoes" are fitted to "run" well.

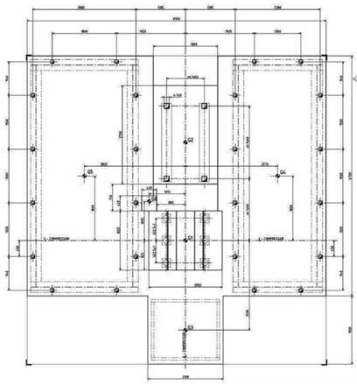
The "footwear" of the compressor is that what links it to the foundation:

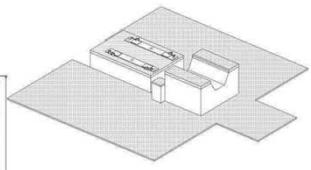
1. Skid or
2. Anchorage and
3. Grouting

... and underneath is the foundation which shall be designed and built such to be a solid "walkway" !

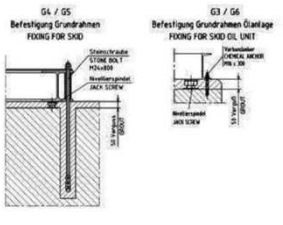
Installation

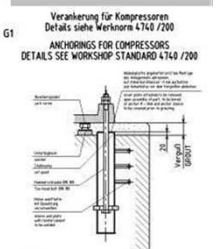
Installation / Foundation Check – vs. Plan





Check:
- Dimensions
- Position of Fixation Points
- Orientation of Anchor Sleeves





Dynamic conditions such as max. permissible foundation movement (vibrations) and dynamic foundation loads shall be forwarded with the plan !

Installation / Foundation Check – Corrective Actions

Example for expensive "Corrective Actions"

foundation too short

anchor bolt position was off

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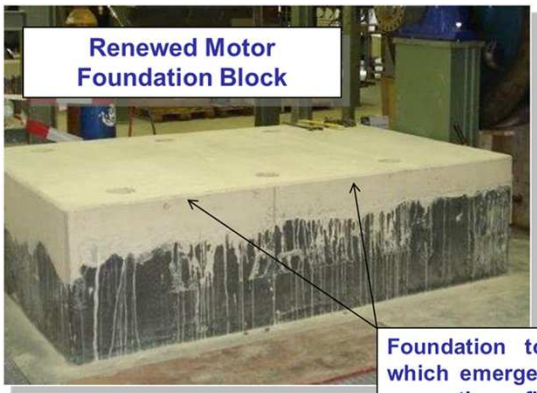
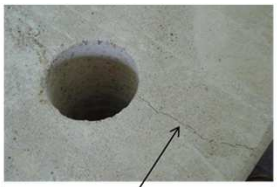
Installation / Foundation Check – Surface Quality





In case of cracks check if only from curing at the top surface or deep through the block

Foundation top covered with mud which emerged during concrete curing generating a fine and sandy dust layer

The foundation top must be clean and rough to allow for perfect link with grouting to come; no (major) cracks shall be present.

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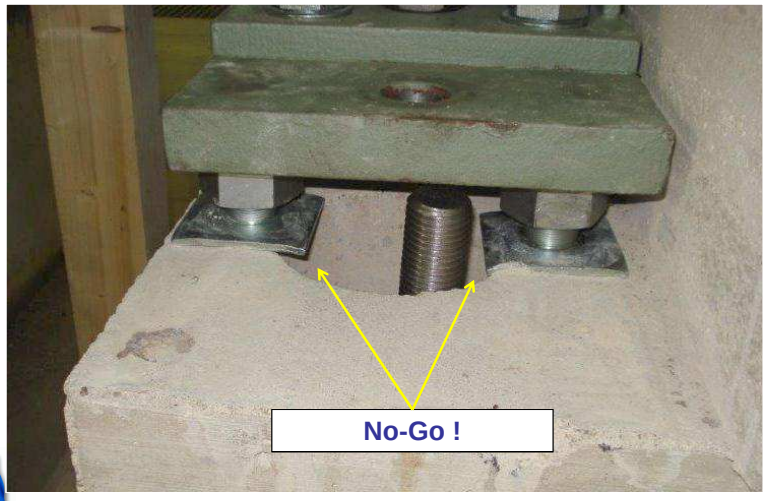
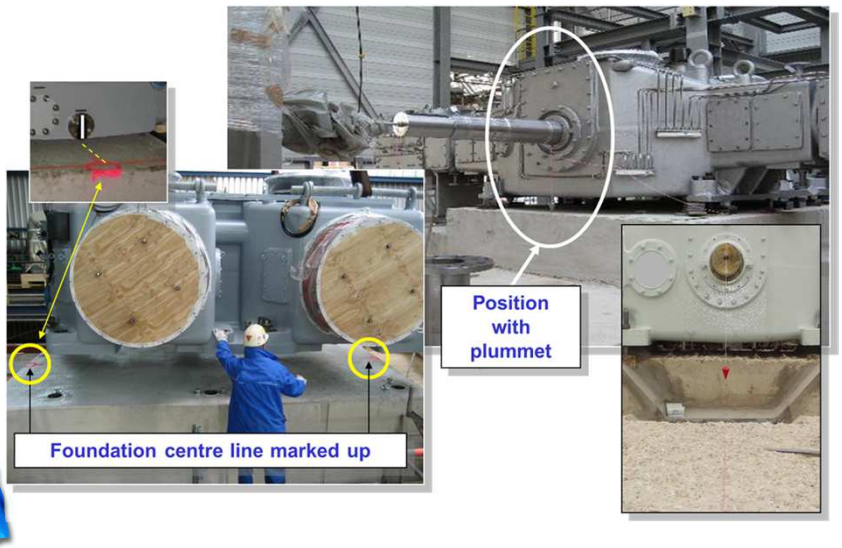
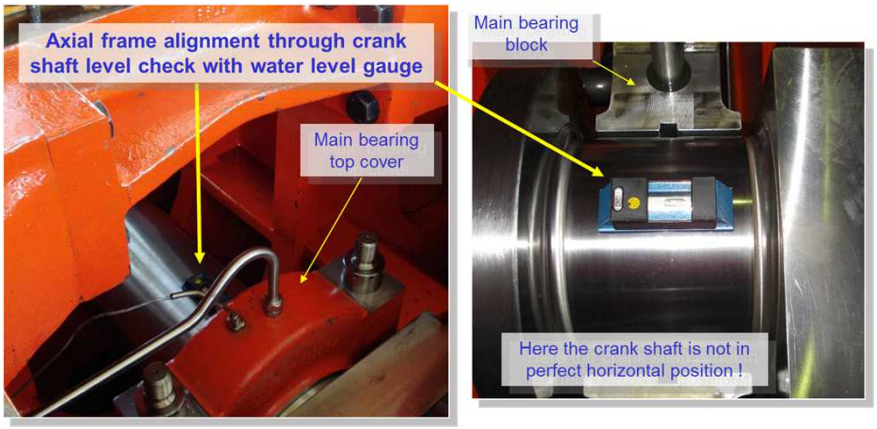
Installation / Foundation Check – Jacking Screws/Spindles



Installation / Frame Flying-in and Positioning



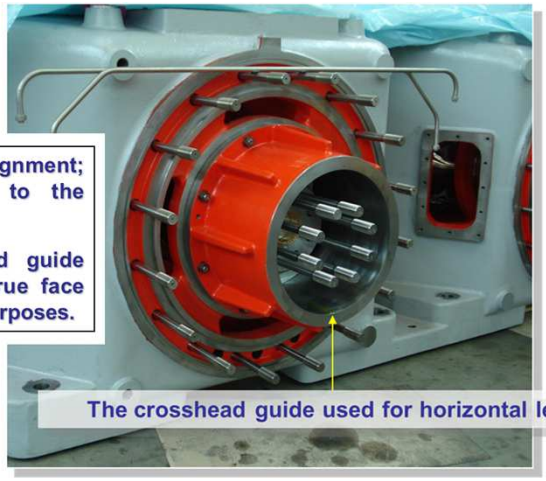
Installation / Frame Level Check - Crankshaft



Installation / Frame Level Check – Crosshead Guide

Horizontal alignment; perpendicular to the shaft axis:

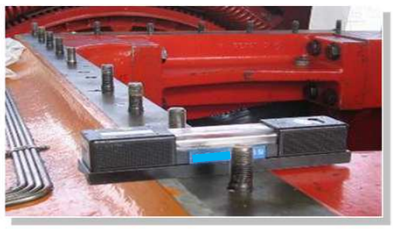
The crosshead guide surface is a true face for levelling purposes.



Installation / Frame Level Check – Frame Top

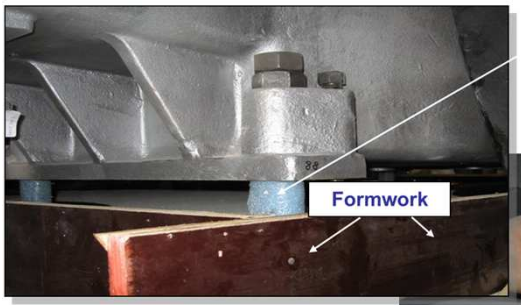
Axial alignment on frame top surface

Level check in horizontal orientation - perpendicular to crank shaft axis



Note: Frame top is not a true face referring to crank shaft and main bearing bore (but often good enough to utilize …)

Installation / Grouting Preparations



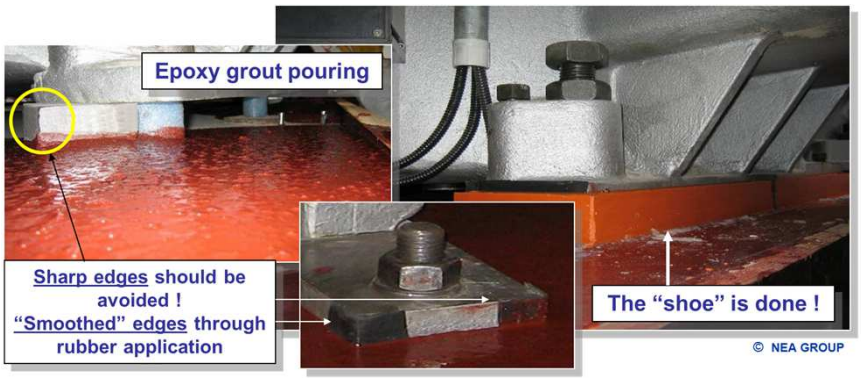
Wrapping of the anchor bolt with plastic foam, rubber or tape (*)

Anchor sleeve to be filled with :

- Glass Sand
- Polyurethane Foam

(*) In comparison with plastic foam or rubber the tape has the advantage of being much thinner, which enables easy fitting through the frame foot.

Installation / Grouting Procedure & Final “Shoe”



2nd layer of epoxy grouting may be required in case of elevated temperatures. Picture right: “Orange” quality on top of “Red” quality with better heat resistance

Operation

Operation / Foundation "Wear and Tear"

Foundation and grouting deteriorate from:

- Unbalanced mass loads
- Oil penetration into the grouting/concrete
- Unfavourable ambient conditions; such as ice formation; corrosion from aggressive atmosphere and ground water penetration
- Loose or cracked foundation bolts

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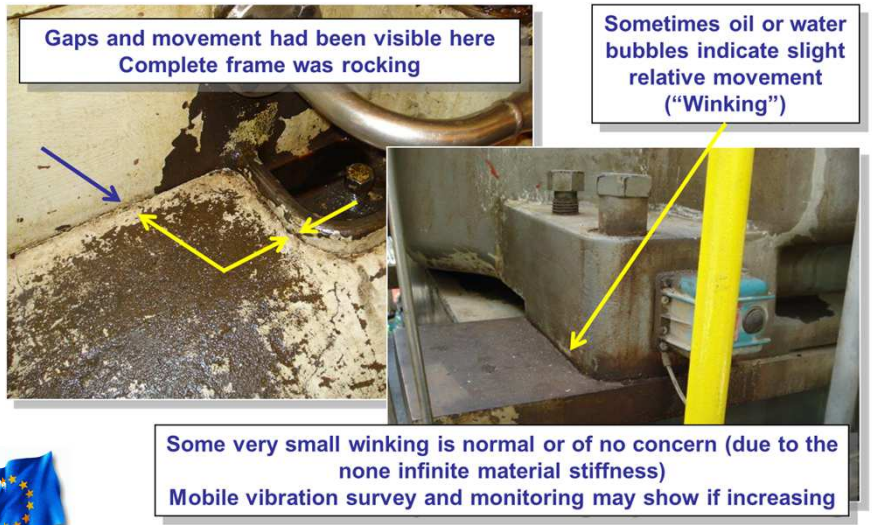
Operation / Frame Foot Movement - Check



Some very small winking is normal or of no concern (due to the none infinite material stiffness)
Mobile vibration survey and monitoring may show if increasing

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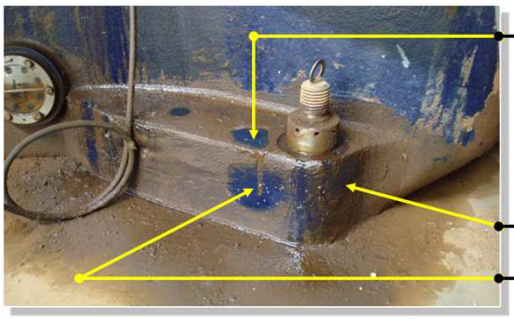
Operation / Frame Foot Movement - Vibration Monitoring

Frame foot oil contamination and relative movement

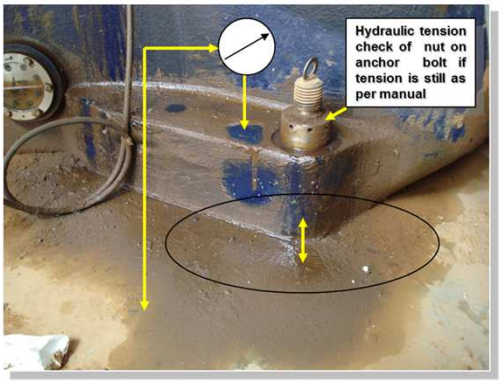


Mobile vibration measurement in 3 axes applied here to verify situation

Future checks recommended to monitor development

If oil penetrated between foot and shims (frame support) it is difficult to regain full strength to keep machine properly fixed on the foundation

Operation / Frame Foot Movement – Tightening Check

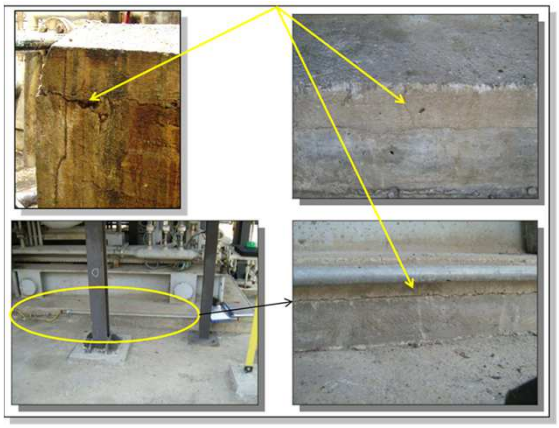


Application of dial gauge to identify foot movement in vertical direction when hydraulic pump pressure of the nuts on the anchor bolts is checked and – in case of lost tension – brought back to specified level.

In case of major dial gauge off-set the ground / frame foot support has become soft.

Oil contamination long term deteriorates concrete quality.

Operation / Grouting and Foundation – Defects



Such defects are not an indication for an issue.

Cracks as shown often occur.

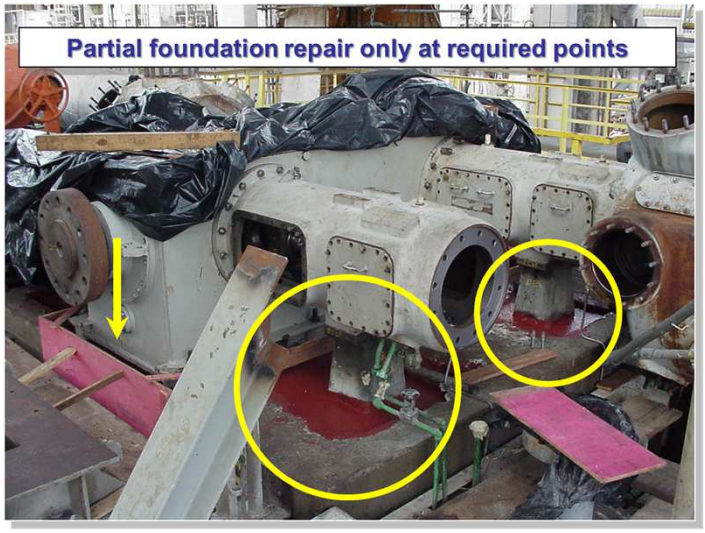
Crack development (if any) must be observed and root cause found.

If foundation is soaked with oil and/or severe movement within unit detected; then action is required.

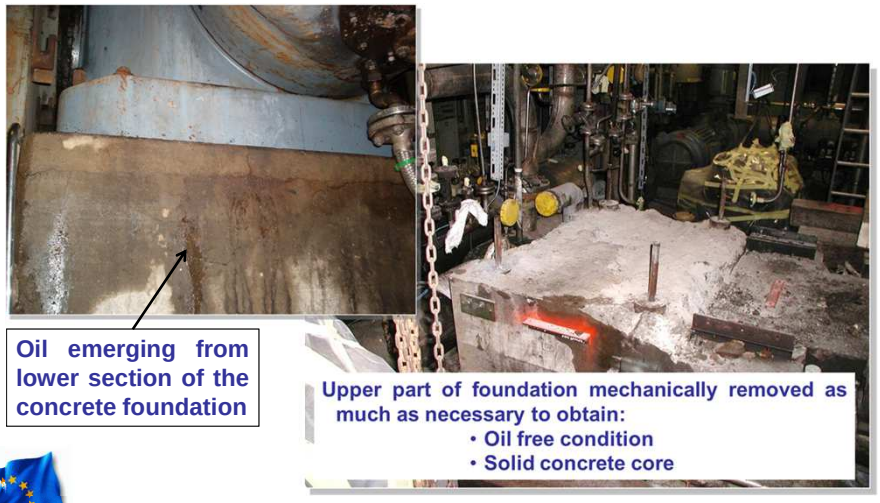
Maintenance

(Repair)

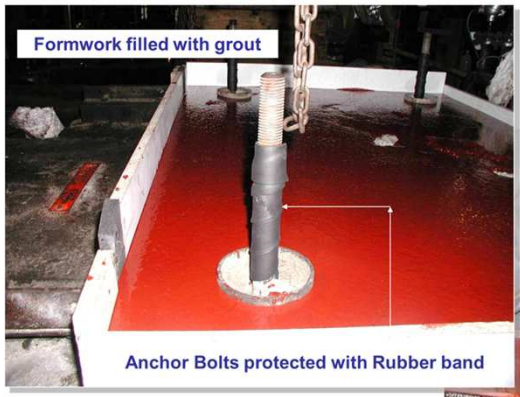
Maintenance / Partial Foundation Repair



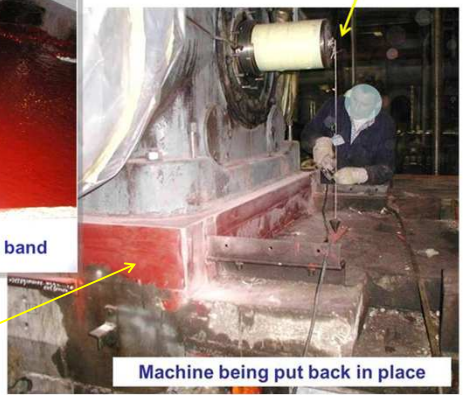
Maintenance / Foundation Repair – Complete Revamp



Maintenance / Foundation Repair – Complete Revamp



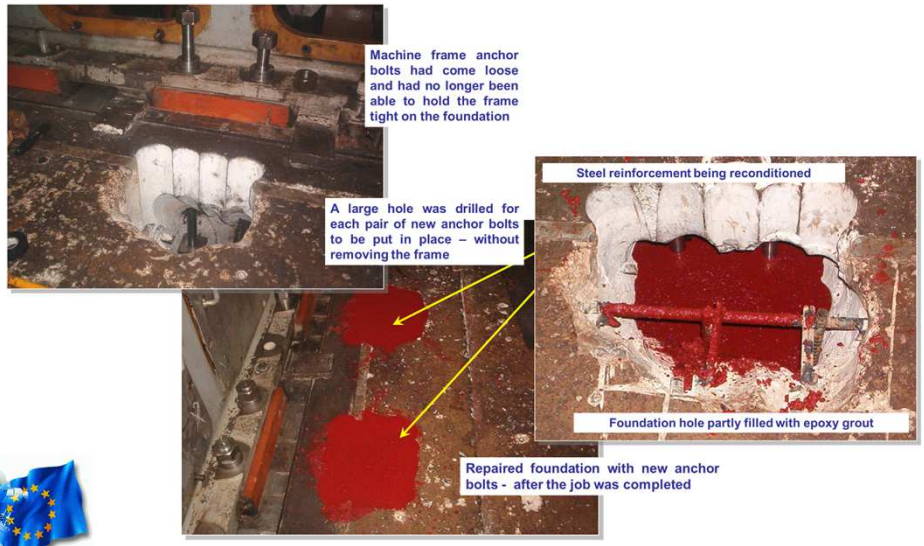
Frame position check with plummet



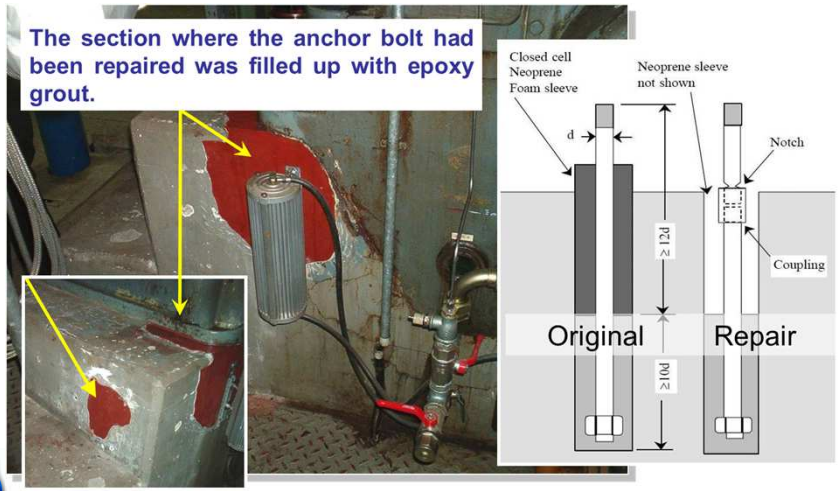
Epoxy compound applied as grout

Maintenance / Complete Foundation Repair (In Situ)

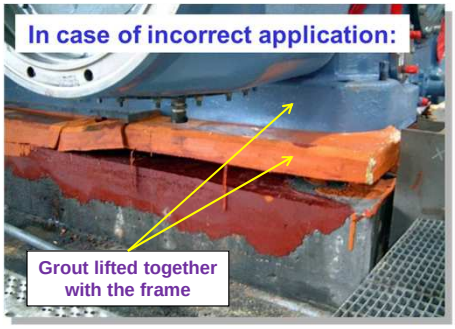
Maintenance / Complete Foundation Repair (In Situ)



Maintenance / Foundation Bolt Repair (In Situ)



Maintenance / Epoxy Grout Issues



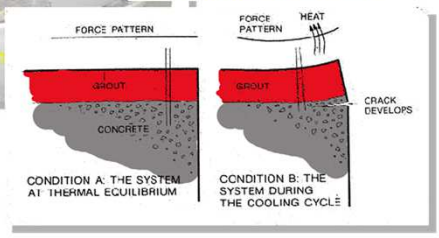
Possible causes:

- Too high temperature
- Wrong mixing
- Poor bonding – presumably due to inadequate surface treatment

Maintenance / Epoxy Grout Issues

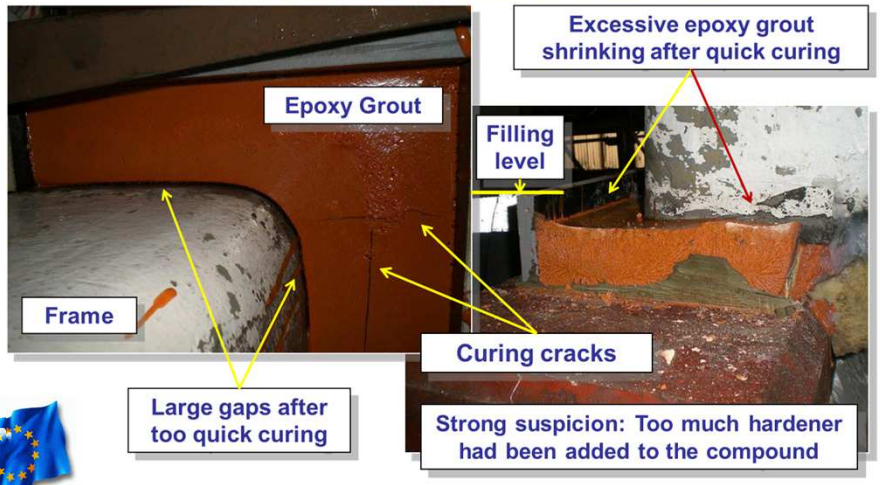
Potential reasons for grout lift up:

- Missing top weight (gap)
- Poor heat transfer from bad/no (top) contact
- High local grout temperature with partially fast curing and uneven expansion/contraction
- High temperature differential between grout and base



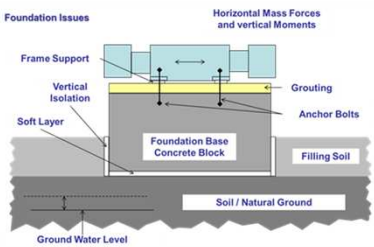
Maintenance / Epoxy Grout Issues

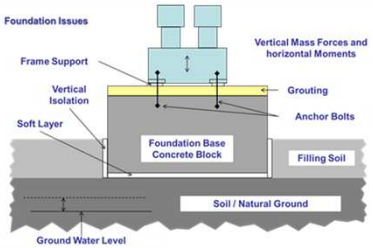
Here – as in many cases – epoxy compound was applied as grouting material; with wide pours; much larger than for typical chocks



Maintenance / Foundation Issues which require Remedy

1. Oil contaminated grouting and concrete
2. Cracks in concrete foundation («Cold Joints»)
3. Soft layer below concrete block
4. Varying ground water level
5. Ice formation
6. «Sandy» foundation concrete (poor quality)
7. Poor grouting quality (soft and/or cracked)
8. Soft link between compressor frame and foundation ⇔ cracking bolts
9. High dynamic loads and moments
10. Anchor bolt corrosion
11. Poor or damaged (corroded or bent) anchor bolt support at the bottom of the anchor sleeve





The foundation is the “path” on which the compressor is “walking”

Make sure it is comfortable for the machine to run smoothly

Thank you for attending

I hope you enjoyed the presentation

Questions and Comments ?