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Undersøkelser av grout-forbindelser på Gyda

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Post-life inspection scope for Gyda Jacket by DNV:

- UT of fatigue-critical tubular joints
- Check of condition of grout in pile sleeves

Pile grout Gyda - Inspection findings 1

Inspection of joints with short fatigue lives

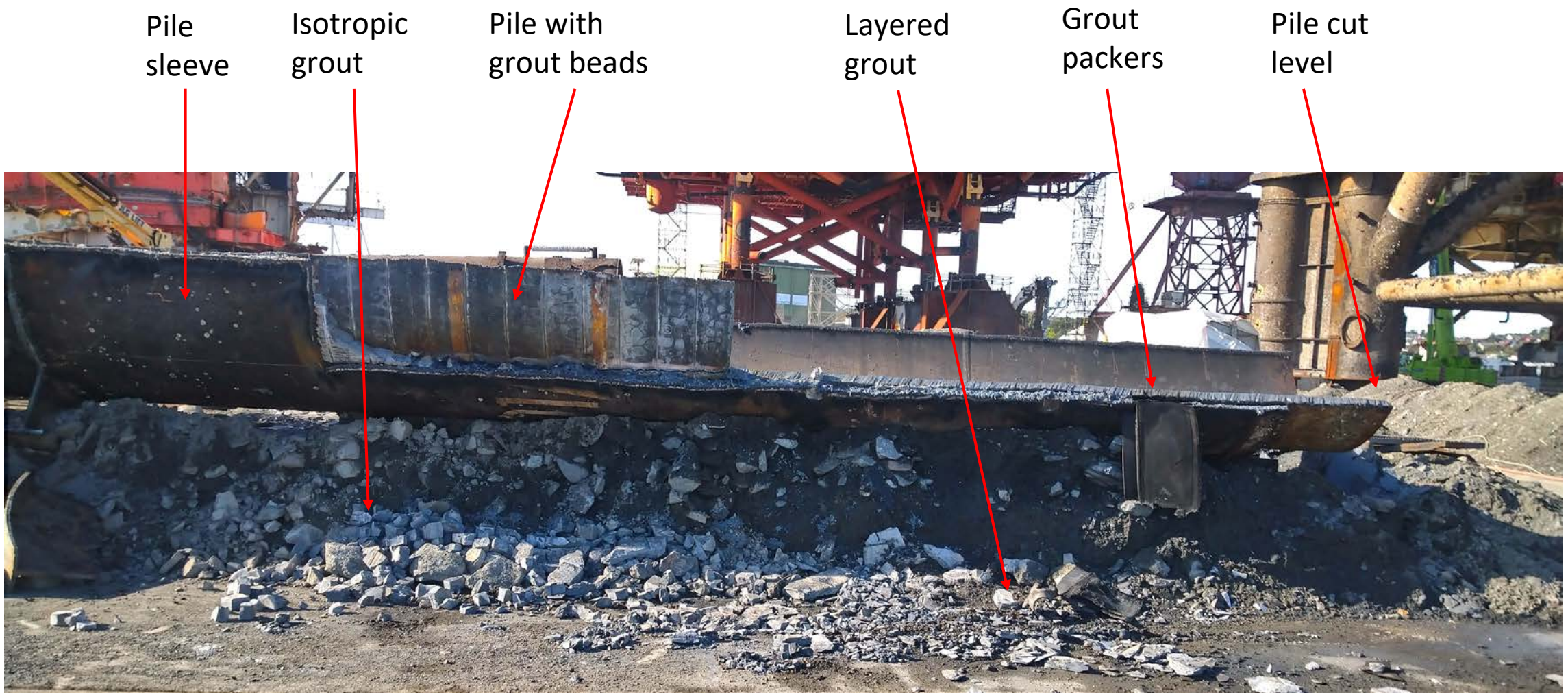
- 6 joints were inspected by DNV UT specialist without any reportable findings
- This was expected since design was done with conservative assumptions, especially for SCFs

Inspection of pile grout

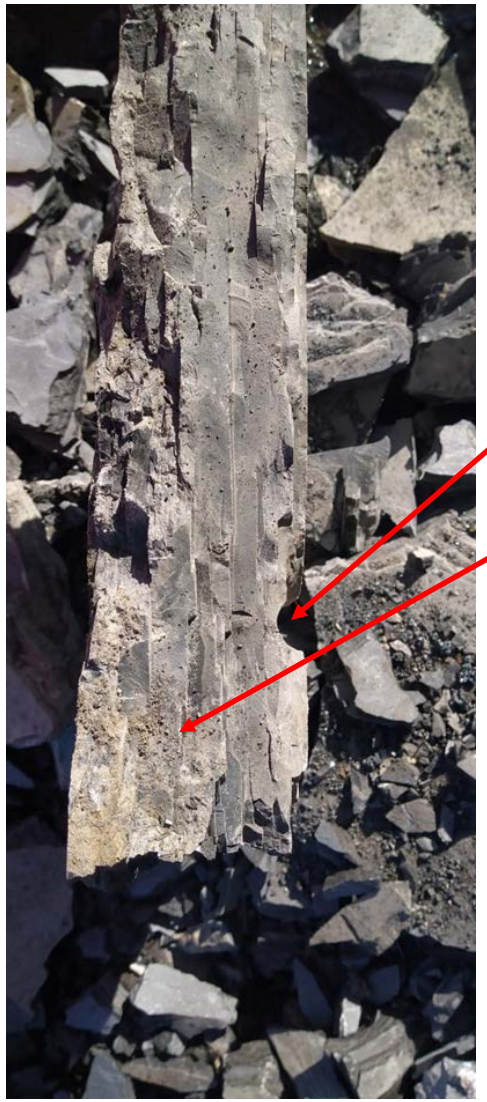
- The grout was in areas found to be layered – not isotropic as expected
- The extent of layering varied from only the lower part to nearly the full height of the pile sleeves

Pile grout Gyda - Inspection findings 2

Initial Repsol observations during early decom site visit before DNV testing:



Pile grout Gyda - Inspection findings 3



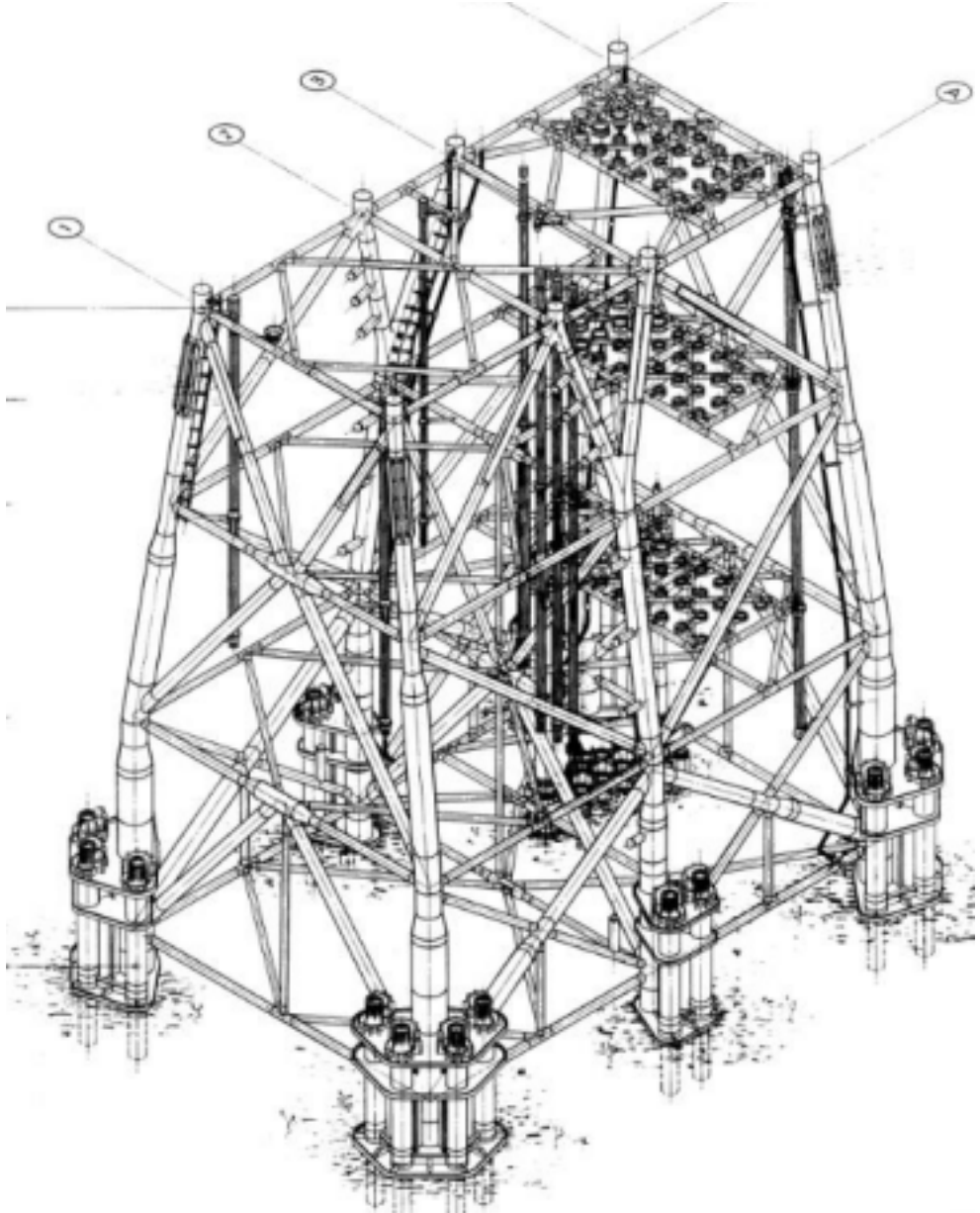
- Intact grout around bead marks
- Some strength between grout layers
- No visible sliding beween steel and grout

Pile grout defects and criticality

Layered grout from lower part of sleeve

Isotropic grout from upper part of sleeve

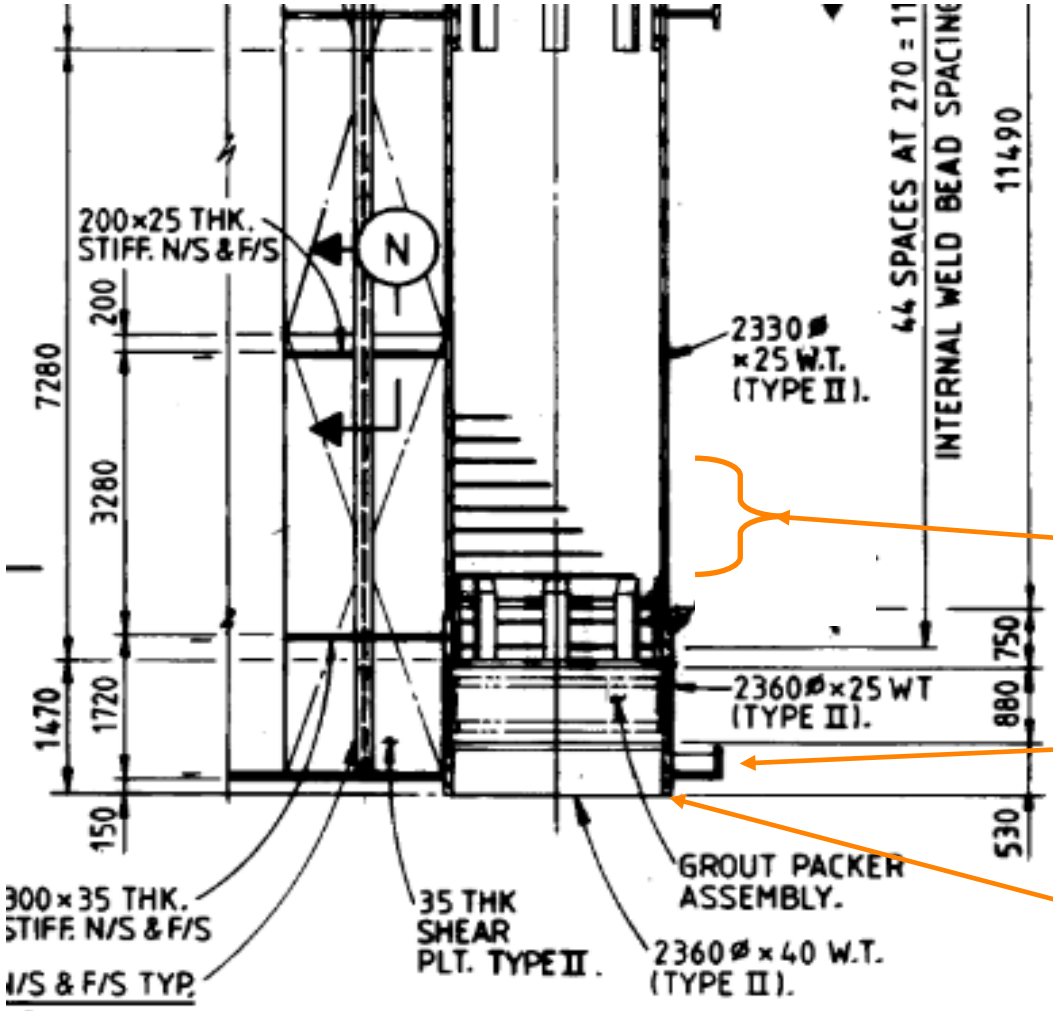
Pile grout Gyda - The Gyda jacket



GYDA JACKET

- 6 leg jacket
- 67 m water depth Southern North Sea
- Built, transported, installed and removed vertically
- Installed 1989
- Some 10 000 t at removal
- 20 piles
- Docked over template
- No skirt below mud-mat
- Double packer system in sleeve above mud mat
- Grout starts above packers (1 m above mudmat)
- Piles may be in tension during storms

Pile grout Gyda - Pile sleeve



Location of test samples

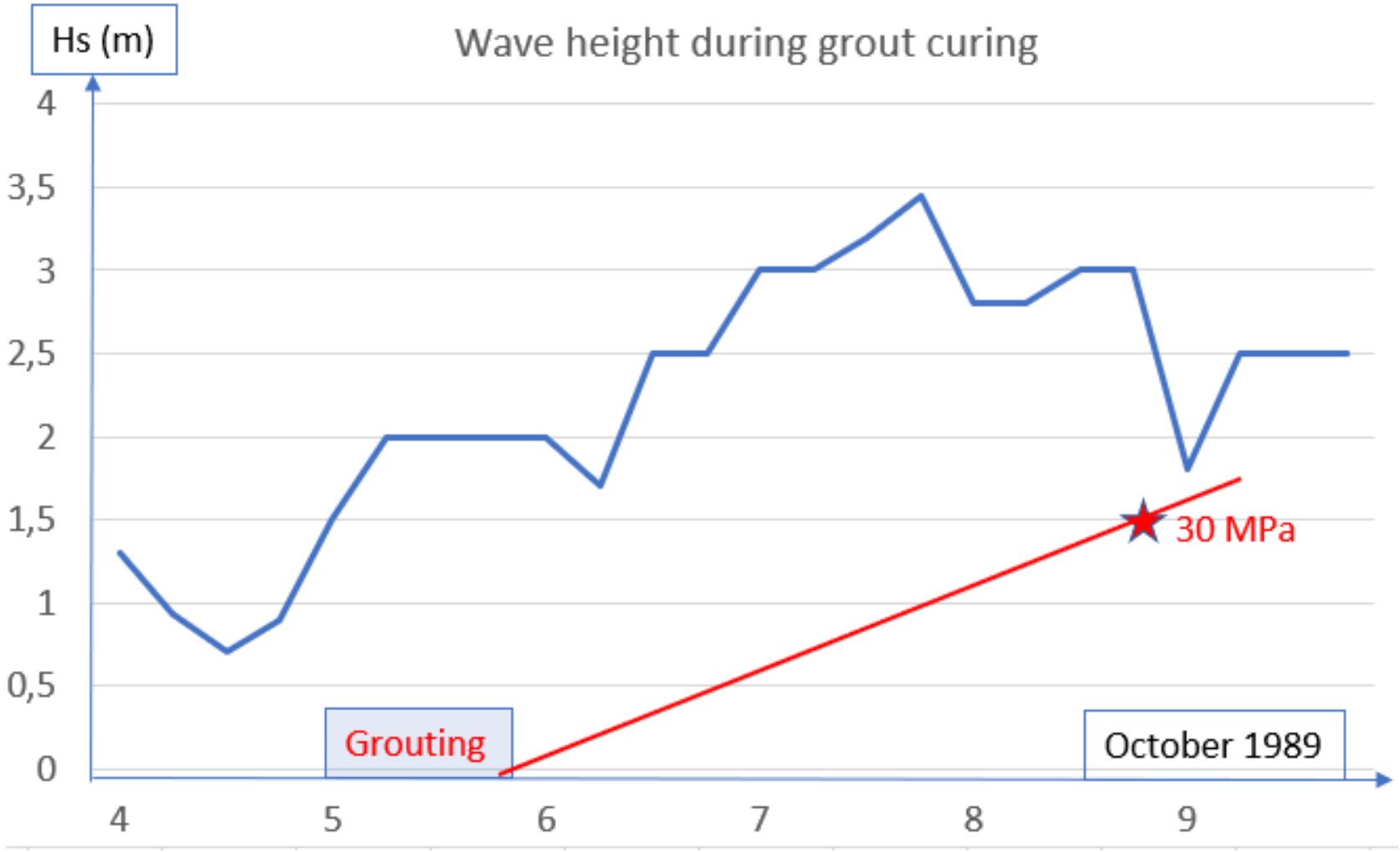
No skirt on mudmat

Sleeve extends approx 200 mm below mudmat

Pile grouting

- Grout:
  - 100 parts by weight cement (Class G of API spec-10)
  - 36 parts by weight sea water.
- Measured specific gravity between 2.02 and 2.08.
- 2 densitometers at each sleeve
- 3 days strength: Min. 26.9, average 30.5 and Max 42.0 N/mm2.
- Pile grouting completed in some 20 hrs.
- No special circumstances reported

Pile grout Gyda - Gyda jacket installation 2



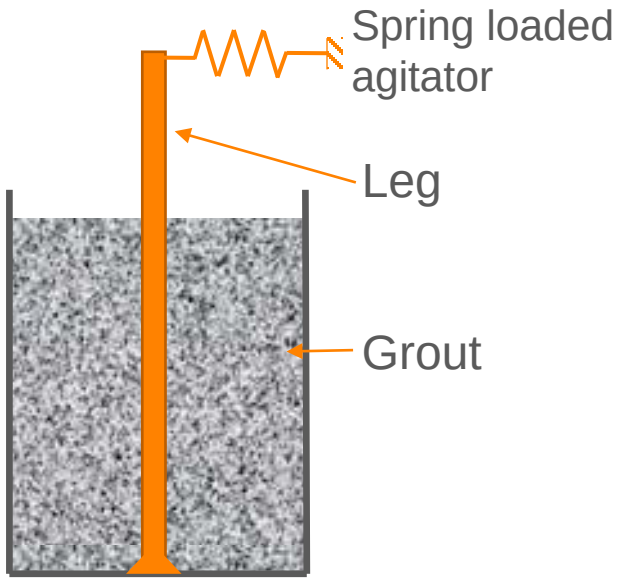
Weather conditions were not ideal but still considered to be acceptable

Testing of tubular connections:

- Grout curing for test pieces are normally done without dynamic loading

- Testing of cured samples normally done with axial loading

Test of unbraced large diameter tubular grouted to sleeve (Note: high strength grout) done in 1998.



- Test performed to investigate grout curing during motions
- Start: Leg moves freely with minimal deflection in spring
- Intermediate: grout cures and spring start to absorb motions
- End: Leg is fixed and spring absorbs motions
- Grout inspected and tested after end of test

Conclusions:

- Moderate motions are restrained and stopped as grout cures
- Grout obtained its specified strength after curing

POSSIBLE REASONS FOR LAYERING

- Motions in grouted connection during curing
- Thermal effects during curing
- Chemistry of cement used in grout

CONCLUSIONS

- The grouted pile sleeve connections on Gyda had no signs of overall failure
- Reason for layering is not fully understood
- Further optimisation of length of grouted connection should be done with care
- Further investigations to see if the layering was specific for Gyda
- Further studies of phenomena are recommended