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USING ENERGY AND HYBRID ENERGY MICROPILES IN UNDERPINNING PROJECTS – THROUGH HOLES IN LOAD TRANSFER STRUCTURES

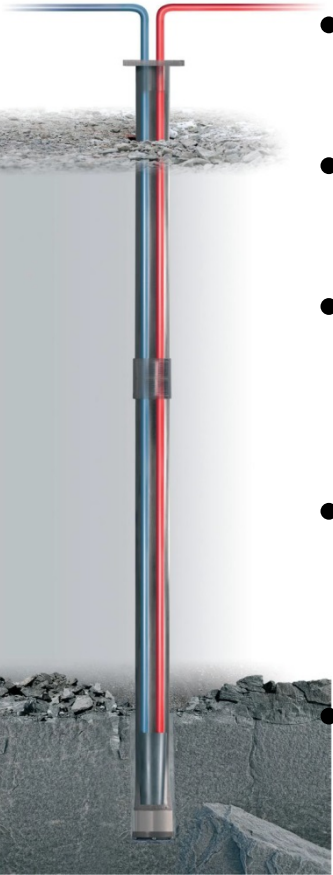
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(also Jukka Rantala in hybrid energypile study)**



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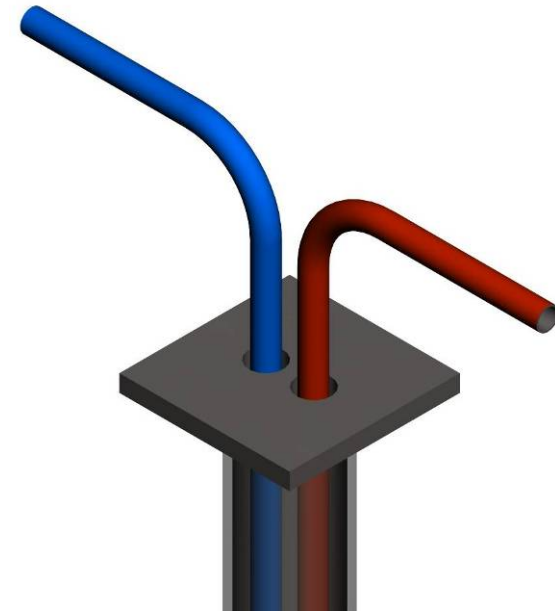
BACKGROUND

- The first projects where openings in the pile casing were used for heat exchange piping are from the early 21st century
- So far all the projects have been large new constructions, for example Zurich Airport terminal E and Main Tower in Frankfurt
- There are no known cases in the world where energy micropiles have been used in renovation projects → new application
- The focus of the study is on load transfer structures transferring the load from old to new deep foundations and on the through holes for ground heat collector piping
- This study is part of FIN-C2M project which is part of Case 2 Micropile Research Project in International Society for Micropiles collaboration.



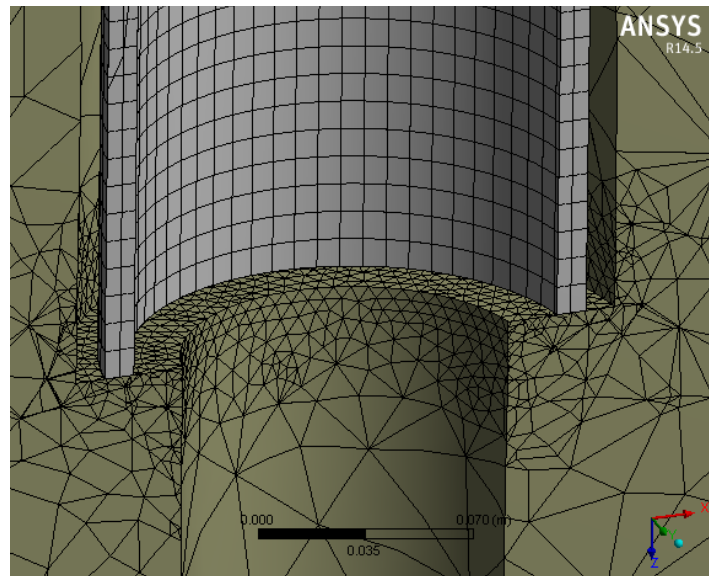
OBJECTIVES

- To examine which types of load transfer structures are suitable for energy piles
- To find the principles how the through hole can be made
- To describe technical solutions for hybrid energy micropiles in underpinning projects in typical Finnish bedrock areas
- To determine the load bearing capacity of drilled hybrid energy pile



THE STUDY

- The thirteen recognized load transfer cases were examined.
- In each case the possibility for through holes in the load transfer structures and leading of pipes were studied.
- Load bearing capacity of a drilled hybrid energy micropile was examined using a basic case where the additional energy heat well was drilled under the pile.



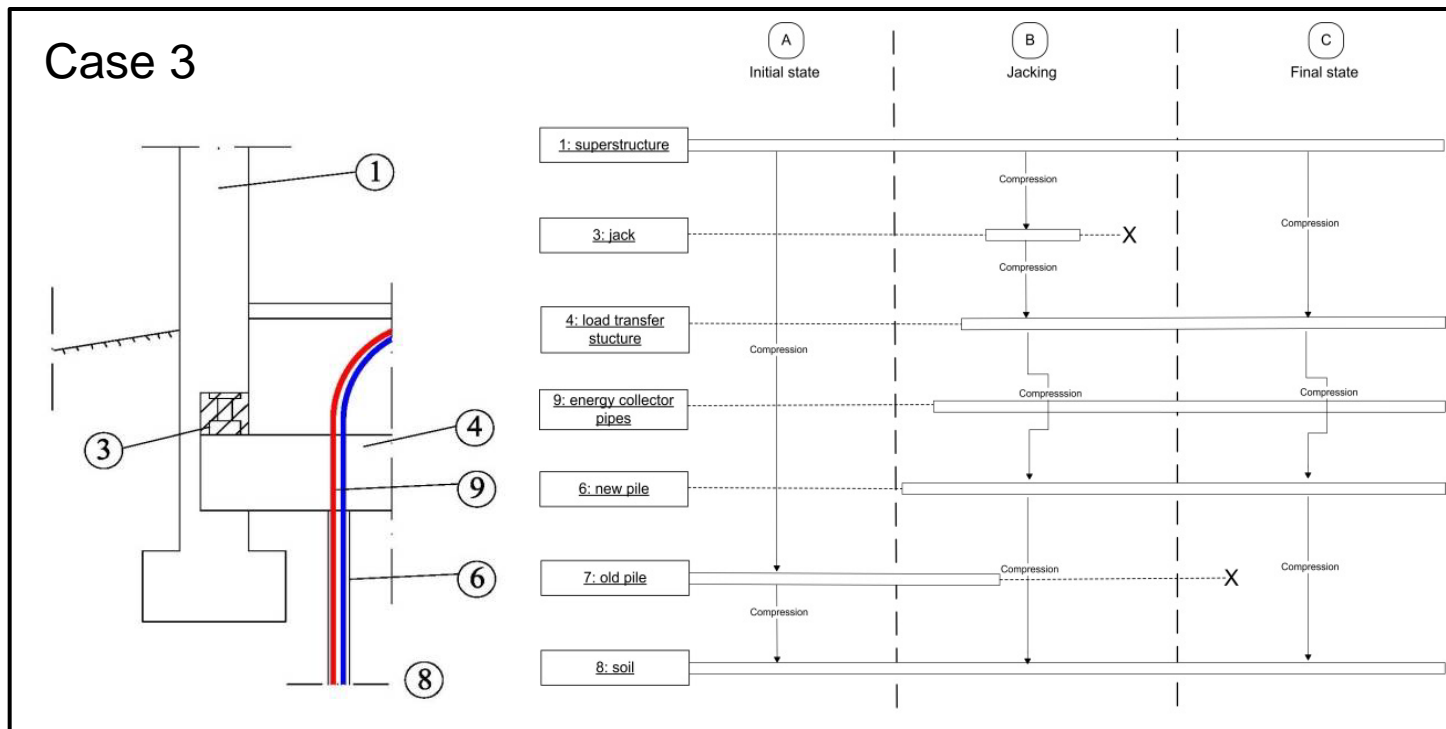
RESULTS 1(5)

- According to the studies nine of the load transfer cases are suitable for use with energy piles
- The through holes for ground heat collector pipes need to be designed in case by case basis
- General principles for through holes can be presented
- Energy piles can not be used with jet grouted columns
- Technical solutions for hybrid energy micropiles in underpinning projects were found
- Possibility to use hybrid energy micropiles to gather energy deeper from bedrock was found.



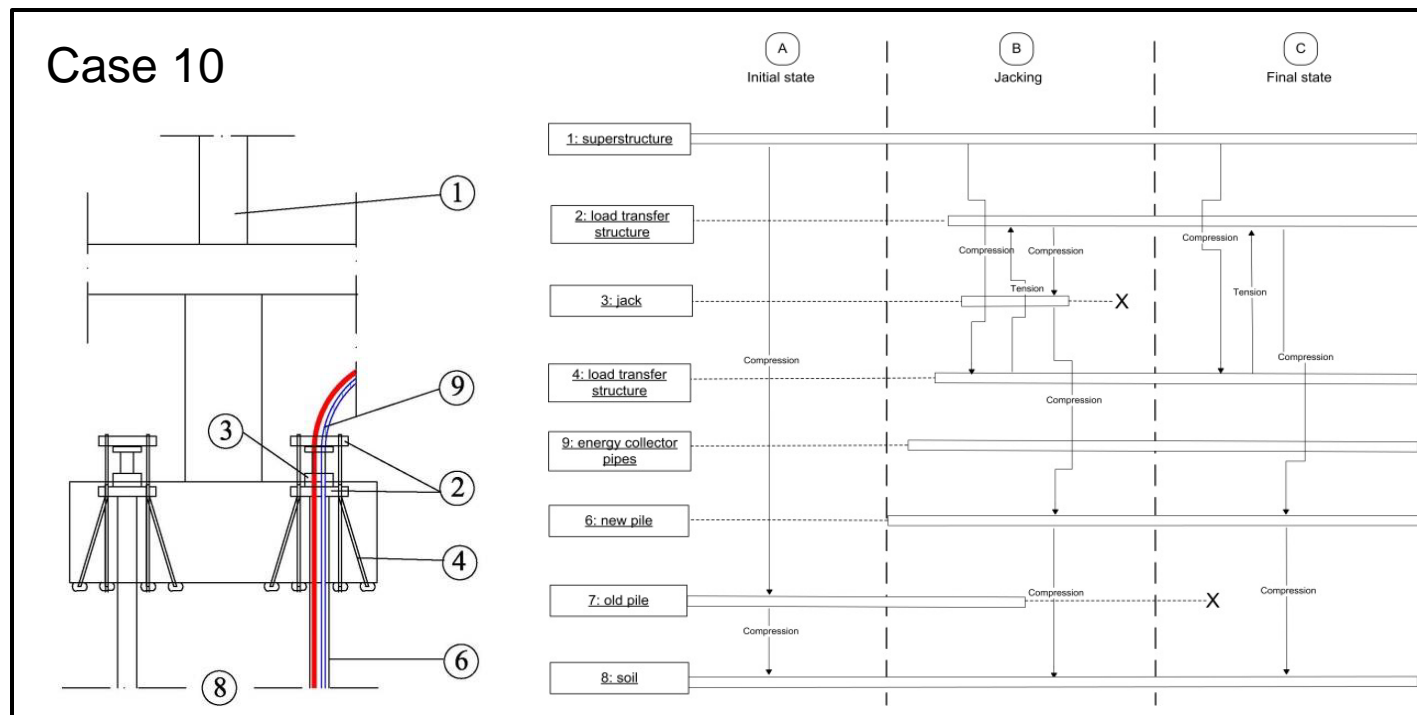
RESULTS 2(5)

Load transfer cases where the ground heat collector pipes can be led directly through the pile cap (cases 2, 3 and 5)



RESULTS 3(5)

Load transfer cases where pipes have to be led out through the side of the pile before the pile cap or to use the special jack system (cases 9, 10, 11 and 12).



RESULTS 4(5)

The hybrid energy pile.

Distance between hybrid energy piles > 15m acc. Finnish energy well regulations.

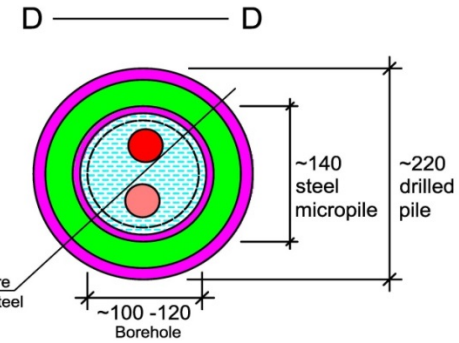
Aligned piles can be applied!



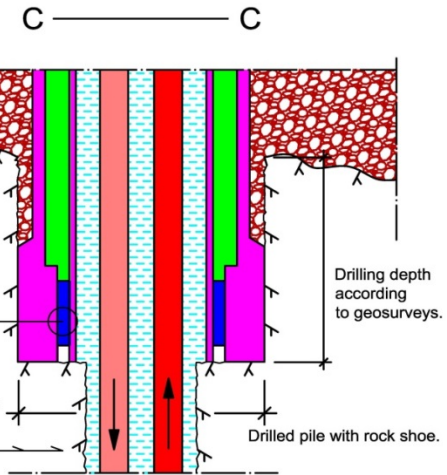
Case: A cellar of an existing, perched water table, wooden piles. Building is sinking and must be piled.

Energy pile. Mean between energy piles > 20m.

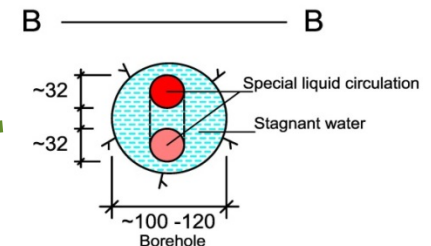
Composite structure steel / concrete / steel



Drilling depth according to geosurveys.

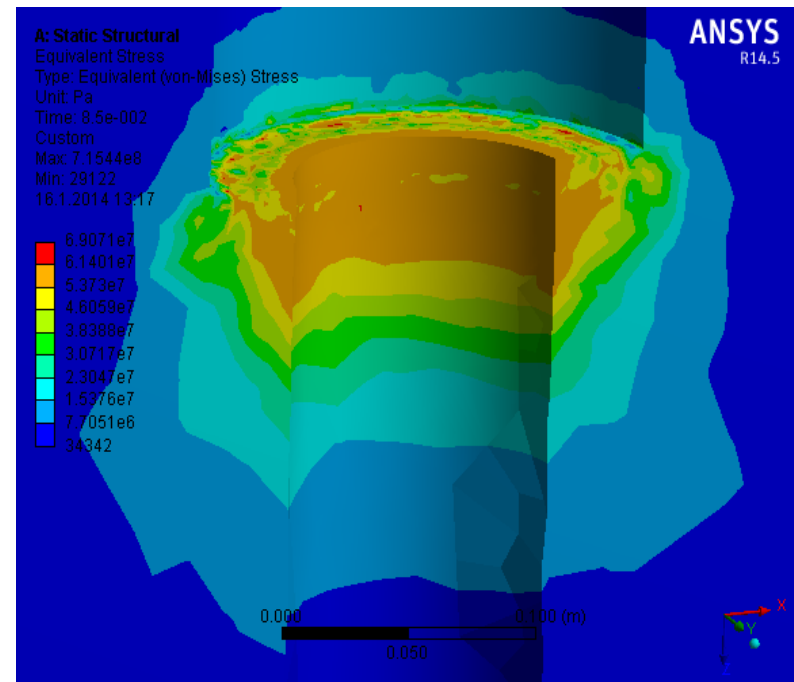
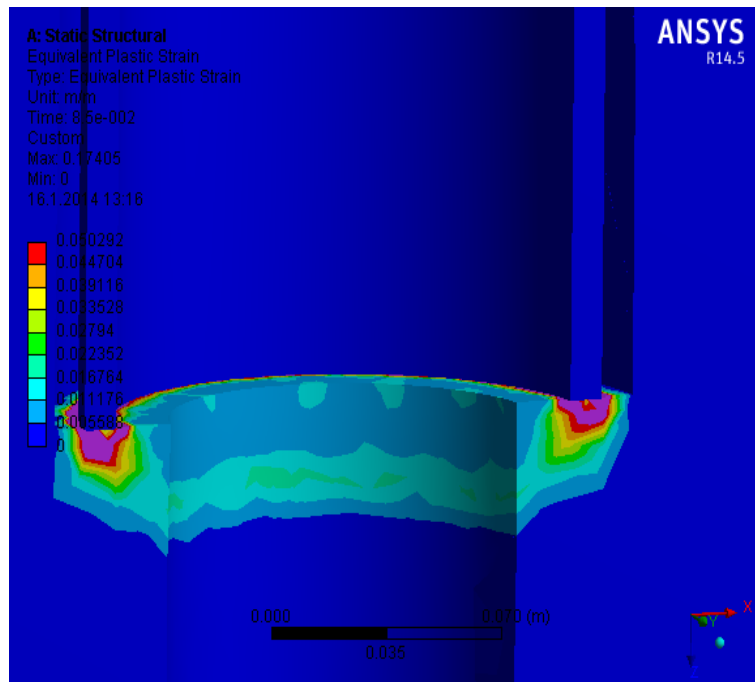


Drilling depth according to geosurveys.



RESULTS 5(5)

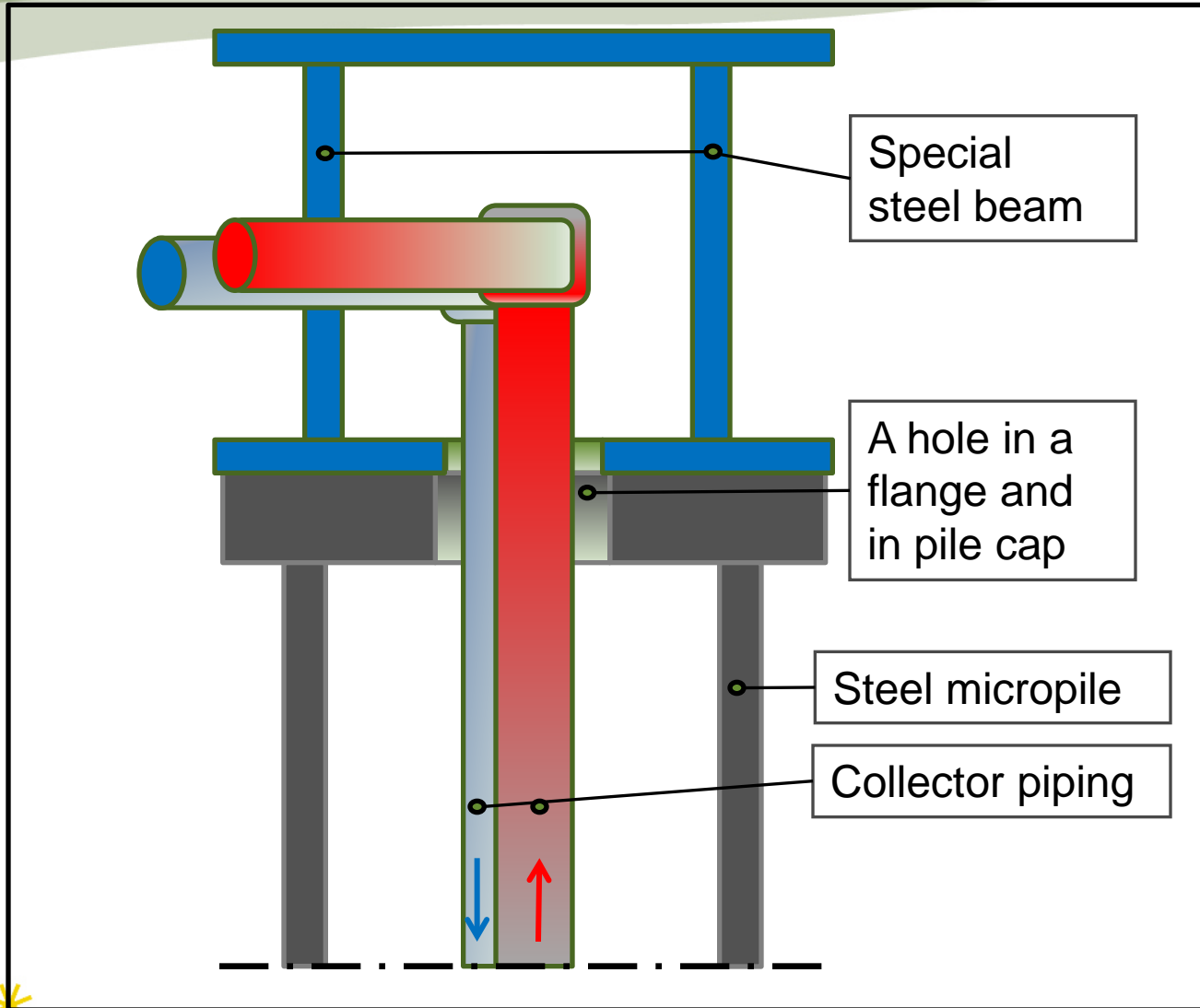
Plastic deformations at the rock surface beneath the impact shoe (left) and the corresponding stress distribution (right). Rock strength $\sigma_{ci} = 60$ MPa, the applied axial load $N = 907$ kN.

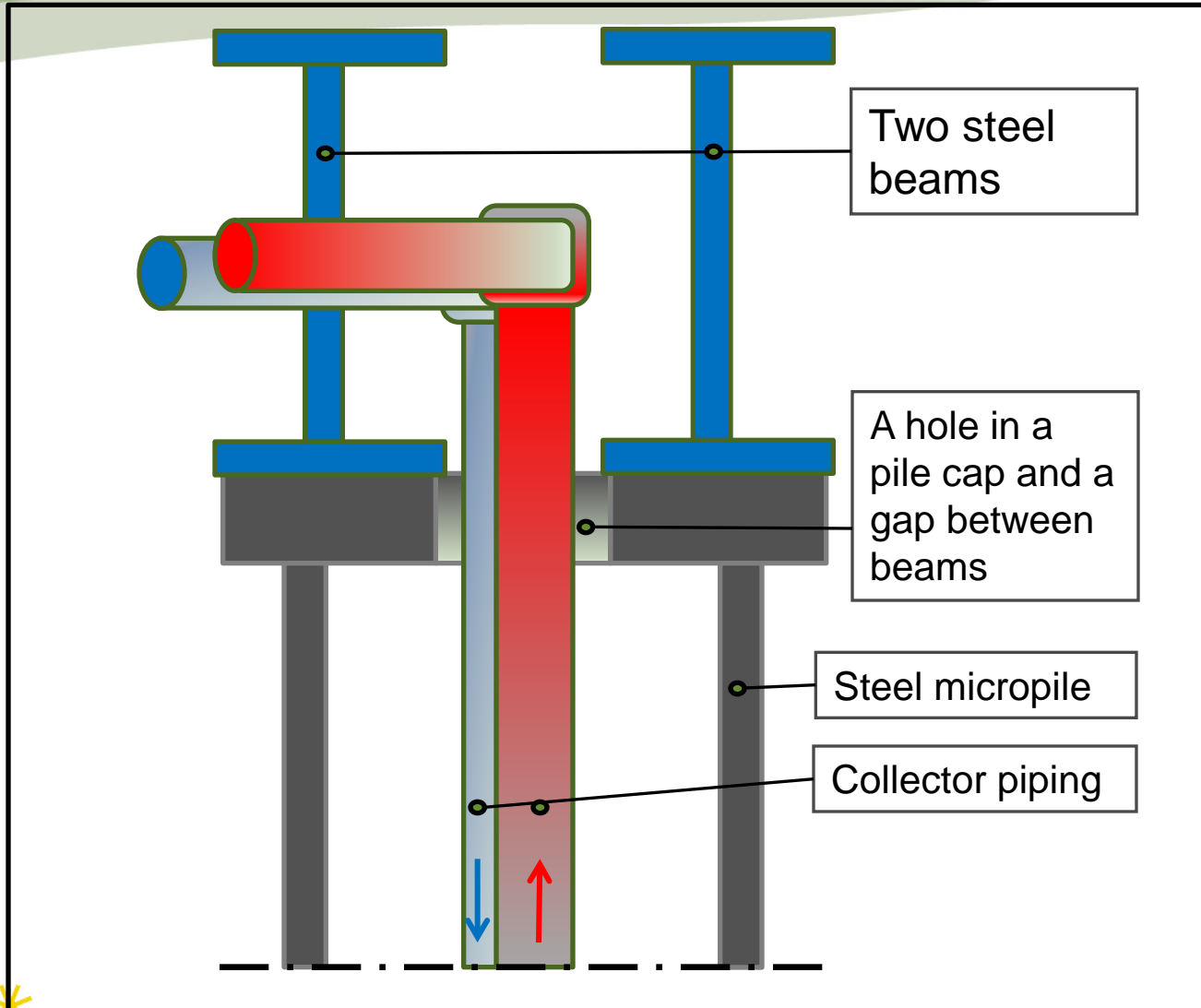


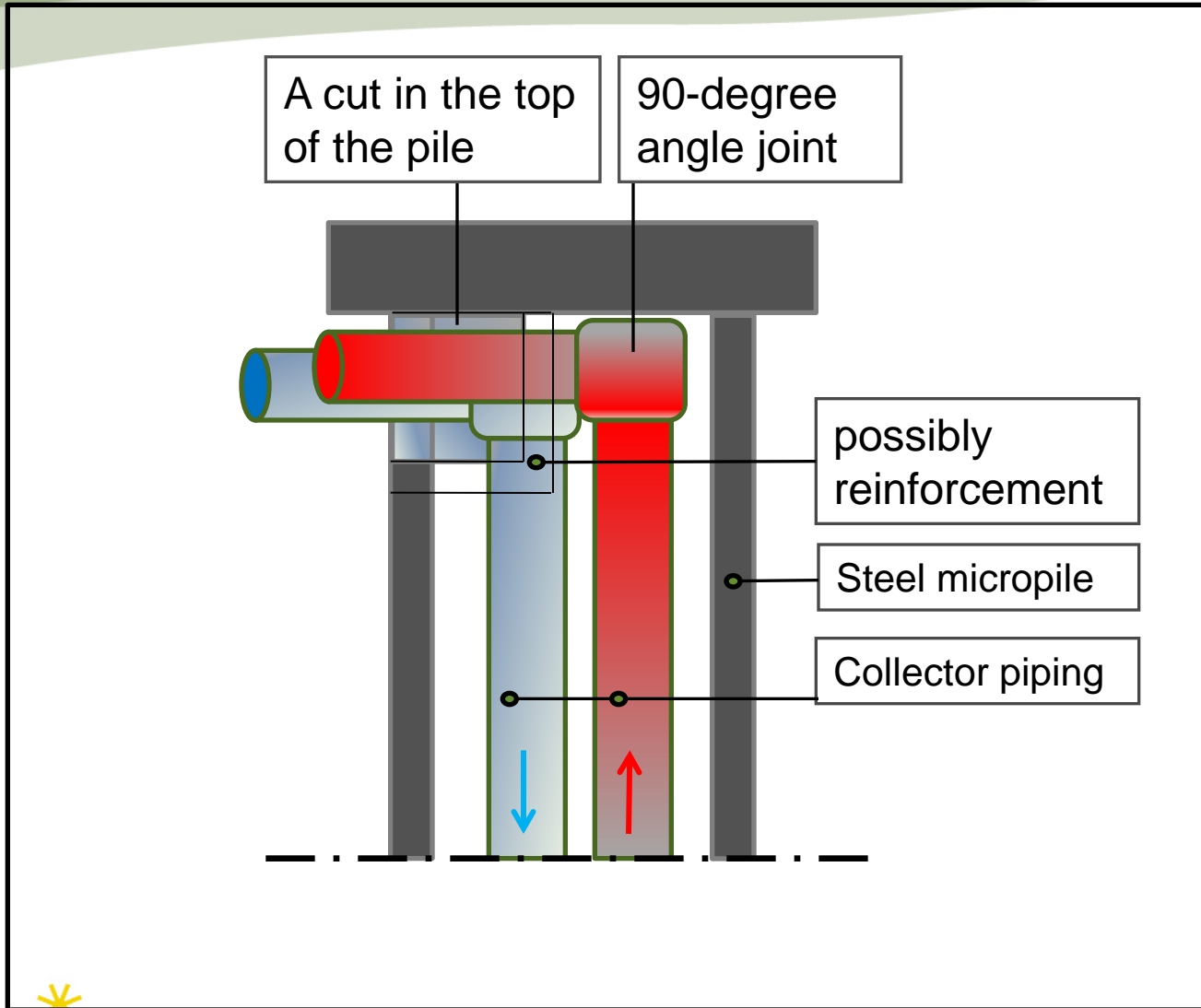
IN CONCLUSION, load bearing analysis

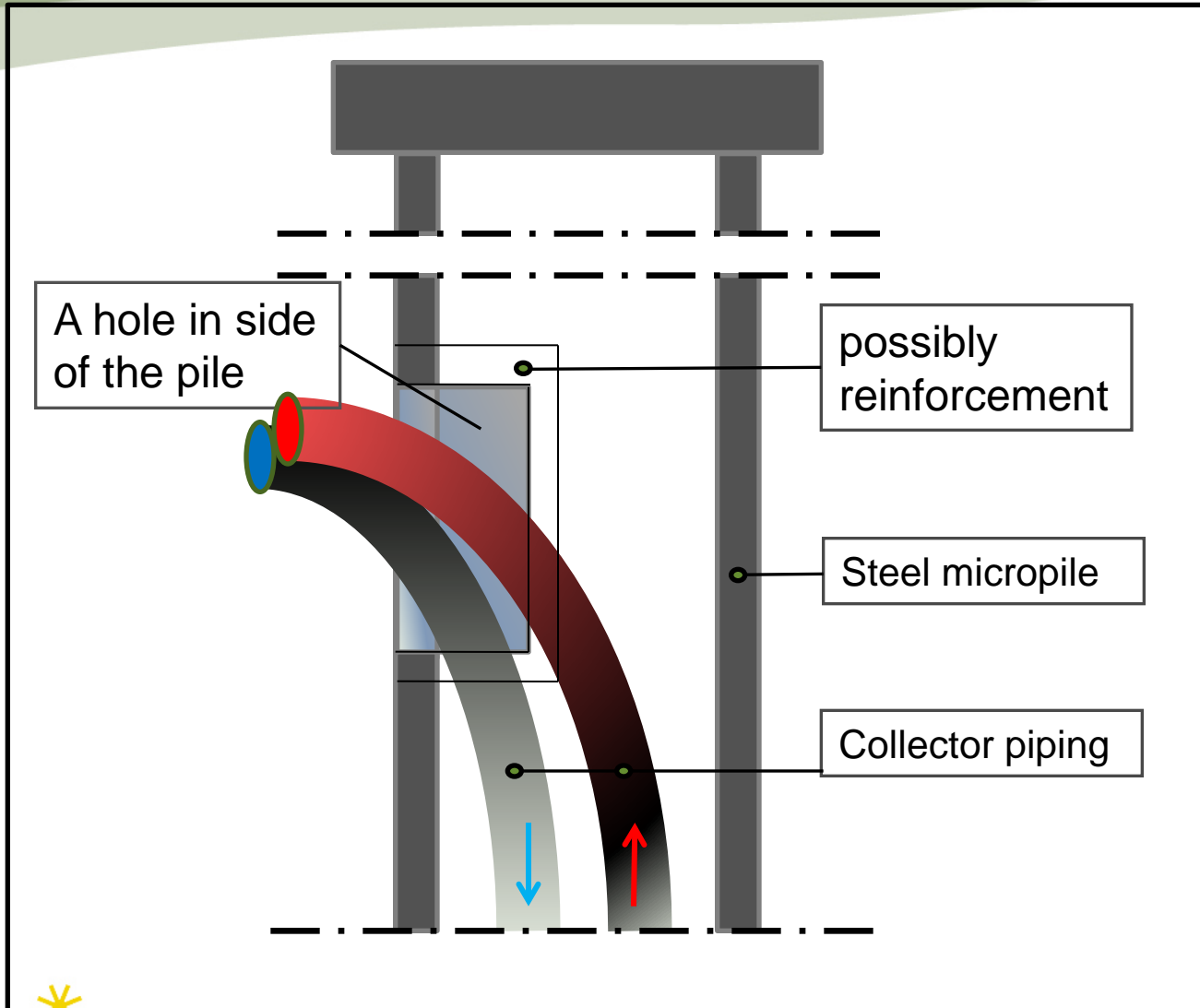
- According to the performed analysis series it is possible to found buildings using hybrid energy micropiles without any additional grouting or strengthening of the pile base.
- By using a load bearing micropile with an adequate diameter (here $D = 168.3$ mm) and providing that the strength of the base rock is sufficient enough ($\sigma_{ci} > 60$ MPa), a standard $\varnothing 150$ mm heat well borehole can be drilled from the base of the load bearing micropile without loosing too much of its capacity.











IN CONCLUSION

- Combining underpinning and energy wells is a new application for steel micropiles
- It promotes using renewable energy resources and improves properties energy efficiency
- Future solution → not yet tested in real life. First case can be soon in Turku!

Thank you!

