

## **Case history in connection with Upgrading of railway system in Norway**

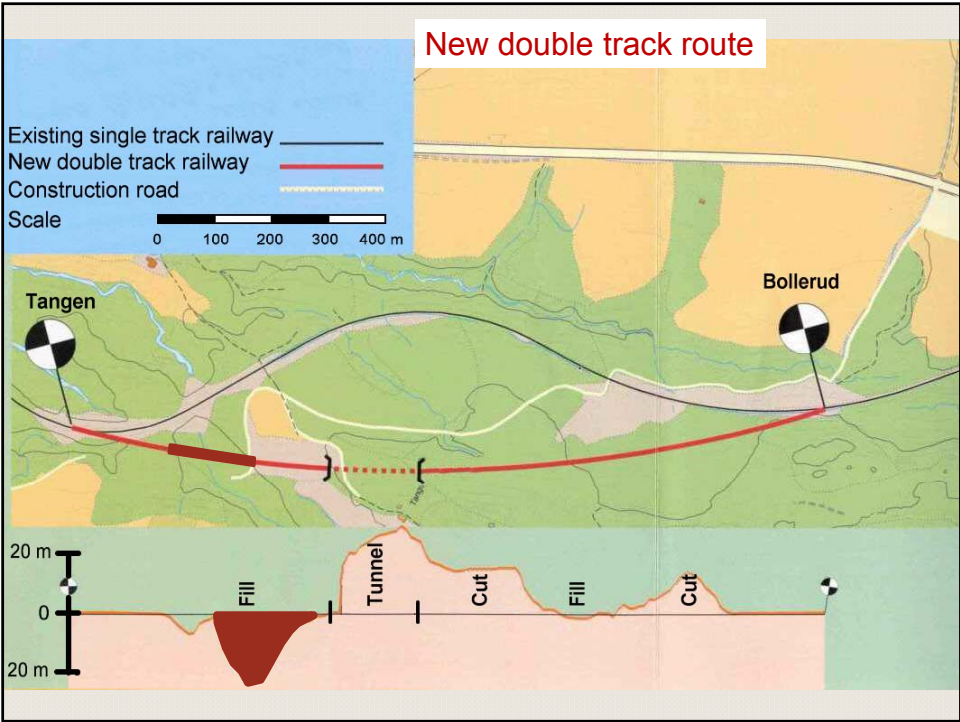
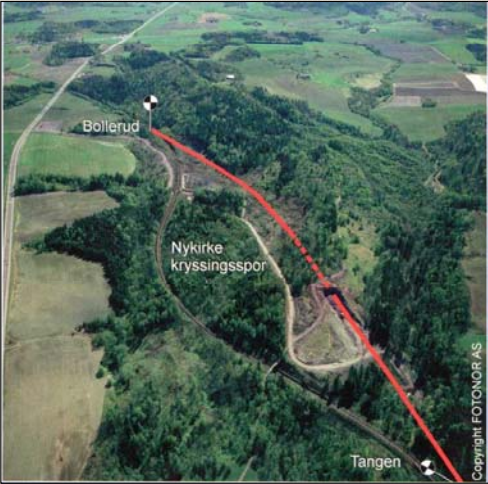


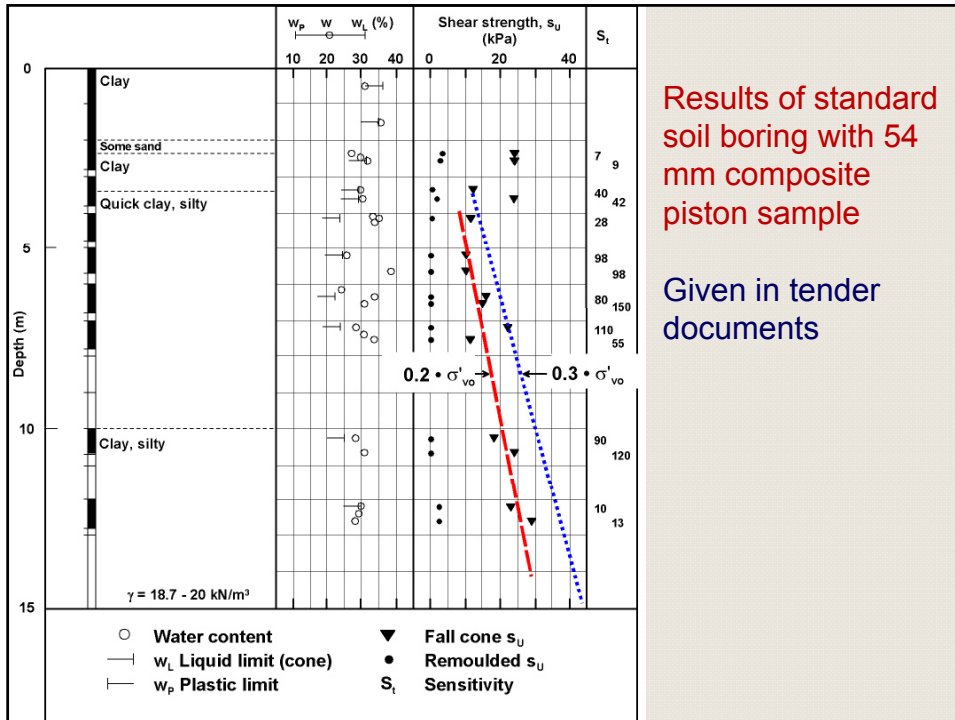
### **New Railway Track Nykirke, Norway**

**CPTU combined with block sampling  
resulted in cost saving solutions for  
new Railway link Oslo to south Norway**

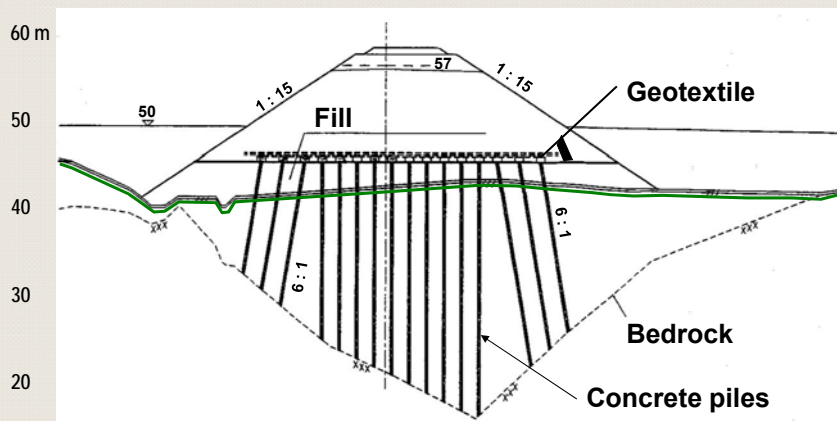
**Aknowledge two colleagues at NGI:  
Steinar Hermann and Tor Georg Jensen, NGI**

# New Railway Track Nykirke, Norway



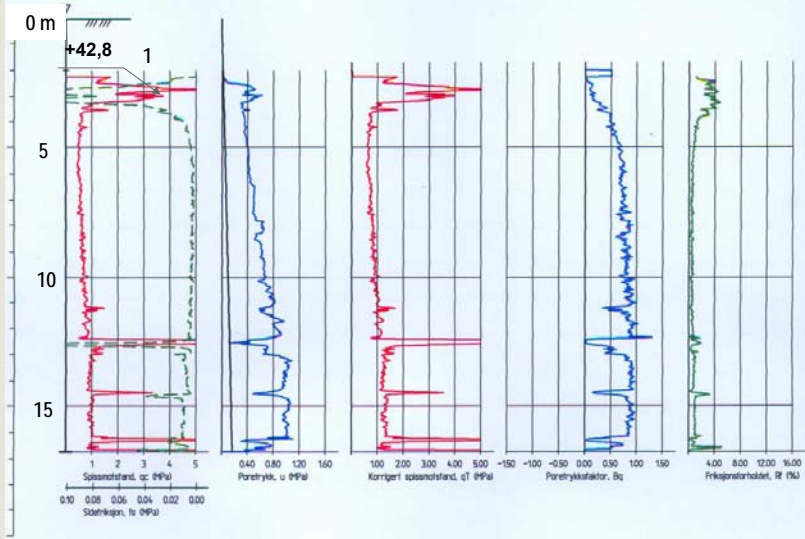


## Initial solution in tender documents



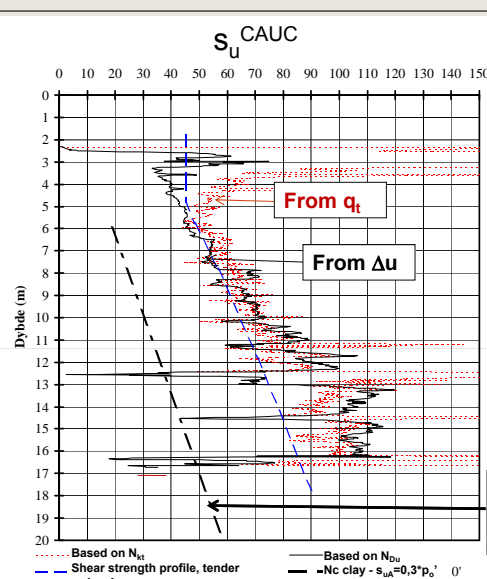
Very expensive solution

## CPTU-Results



New CPTs proposed by NGI were carried out

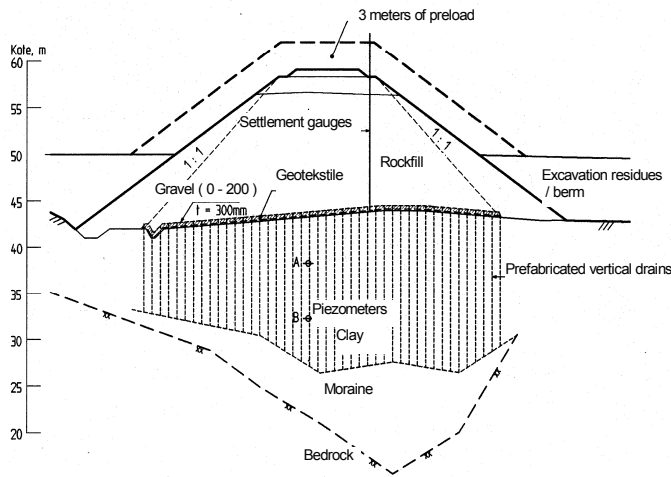
## Undrained shear strength profile ( $s_{uCAUC}$ ), Nykirke Railway Track



Using N-factors John Powell presented earlier today to get  $s_{uCAUC}$  from CPTU

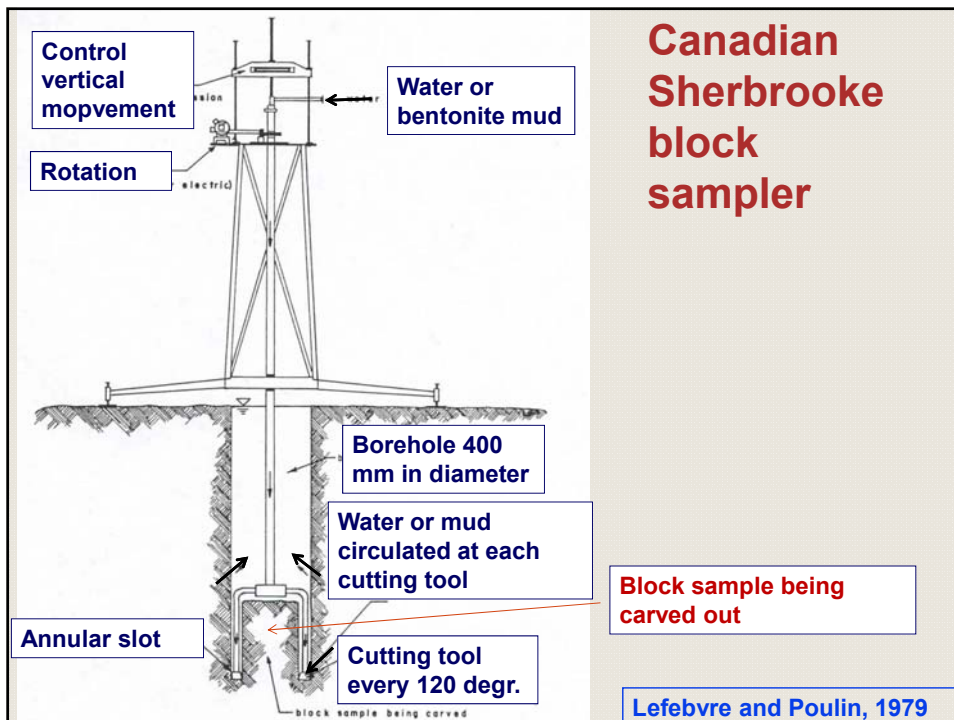
Original design strength given in tender documents

## Nykirke Railway Track, solution based on new $s_u$ profile



New less expensive solution could be found

Use 3 m preload and prefabricated vertical drains to get rid of settlements



## Canadian Sherbrooke block sampler

Block sample being carved out

Lefebvre and Poulin, 1979

NOTES

control of vertical progression (manually)

rotation (mechanic or electric)

water or bentonite mud

borehole 40 cm in diameter

water or bentonite mud circulated at each cutting tool

annular slot

cutting tools at every 120°

block sample being carved (bottom diaphragm opened)

FIG. 6. Schematic view of a block sample being carved.

## Canadian Sherbrooke block sampler

Cutting edge

sherbrooke block sampler

## The drill rig use to operate the Sherbrooke block sampler





Sampler is lowered into borehole

## Block sampling with Sherbrooke sampler



Install casing through upper crust

Sample as recovered



## Block sampling with Sherbrooke sampler

Block sample cleaned and wrapped in plastic cling film

## Sherbrooke block sampler

Sample ready for transportation



Samples were transported to NGI's labs in Oslo in these plastic containers having packed around sample with foam

As we shall come back to this sampler still gives the best quality

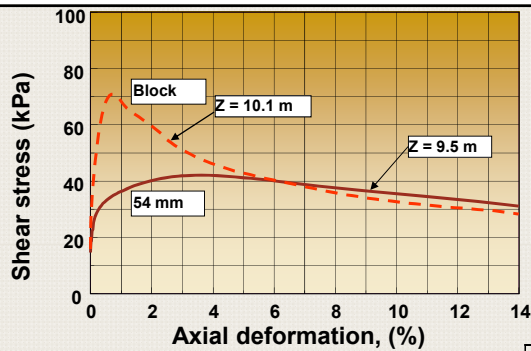


## NGI's Laboratory in Oslo

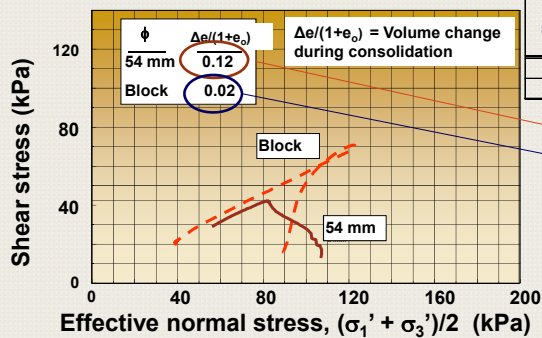




Building in of triaxial sample in NGI's laboratory



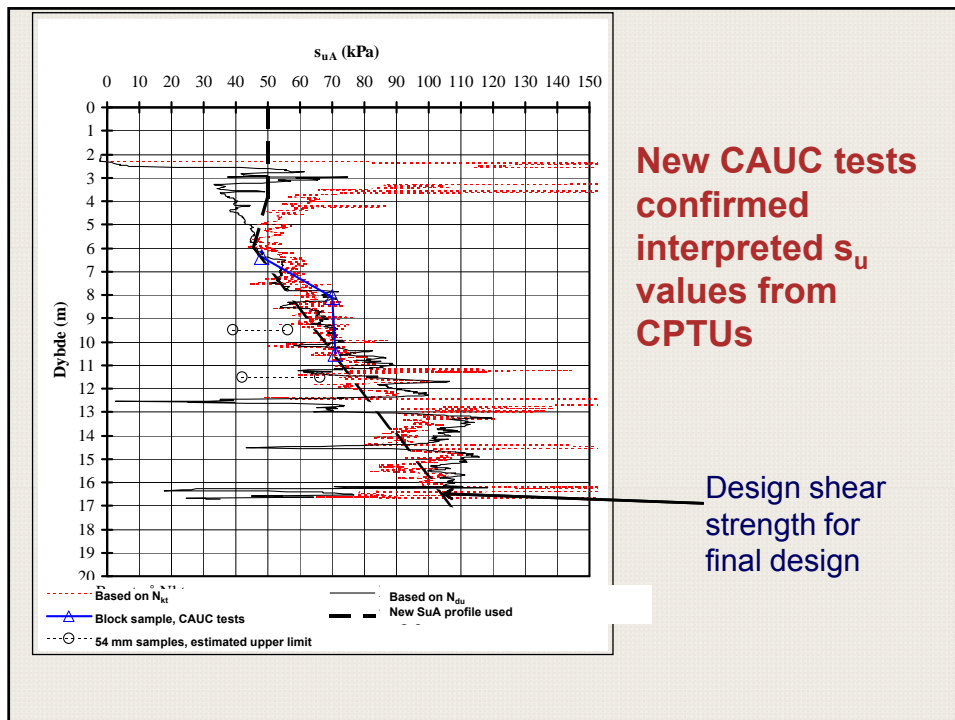
Results of CAUC triaxial tests on new block samples compared with old 54 mm piston samples



NGI scale sample quality

Overconsolidation ratio	$\Delta e$			
	Very good to excellent	Good to fair	Poor	Very poor
1 - 2	<0.04	0.04-0.07	0.07-0.14	>0.14
2 - 4	<0.03	0.03-0.05	0.05-0.10	>0.10

Both  $\Delta e/1+e_0$  values and shape of stress paths confirm much higher quality of block sample



## Case history Nykirke railway track

**Upgraded shear strength profile resulted in possible change in technical solution**

From stability viewpoint not necessary with piles to rock

- Settlements could be taken care of by vertical drainage combined with preloading
- **Total cost savings of about USD 1.2 mill or 25 % of total contract cost**

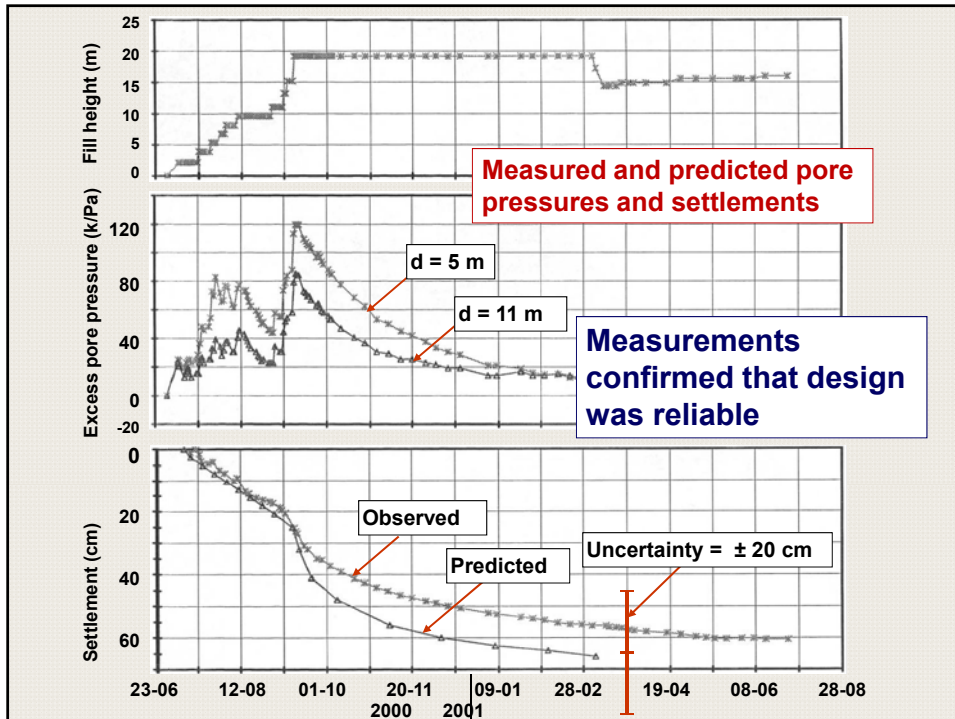
**Nykirke Railway Track  
Placement of prefabricated vertical  
drain**



**Nykirke Railway Track  
Placement of geotextile and 0.3 m  
gravel**



# Nykirke Railway Track Placement of preload rock fill



## Summary and conclusions

- **Block sampling can give significantly better quality than standard piston samples, and for special projects can result in large cost savings**
- **Block sampling, advanced laboratory testing combined with CPTU a powerful soil investigation techniques**

Moscow April 09