

## Roads on peat - challenges and solutions Experiences from the ROADEX Partners

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Barents Low Volume Road Management Seminar  
Rovaniemi, 25 April 2012



Innovatively investing  
in Europe's Northern  
Periphery for a sustainable  
and prosperous future



European Union  
European Regional Development Fund

# Roads on Peat - Challenges & Solutions

## Outline:

- ROADEX Road on Peat
- "Challenges and solutions"
- Icelandic case study



Natural peatland



Replacement on peat



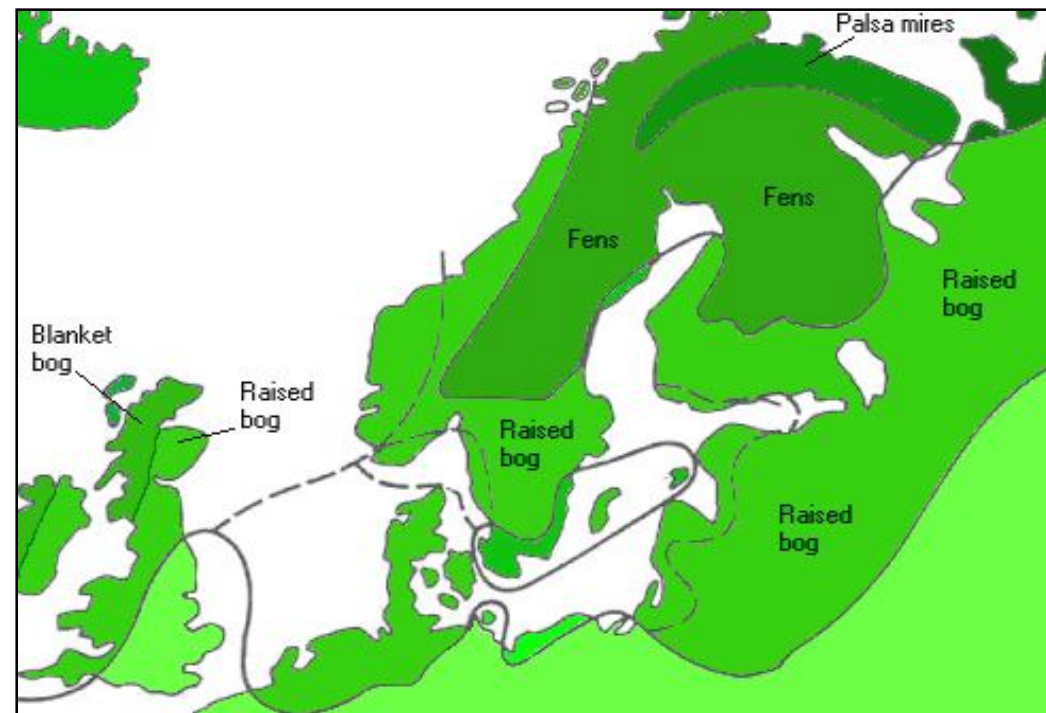
Iceland case study



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# Challenges and solutions: Peat across the Northern Periphery

- Palsa mires
- Fens
- Raised bogs
- Blanket Bogs



*Mire zones across northern Europe, Succow & Jeschte 1990*

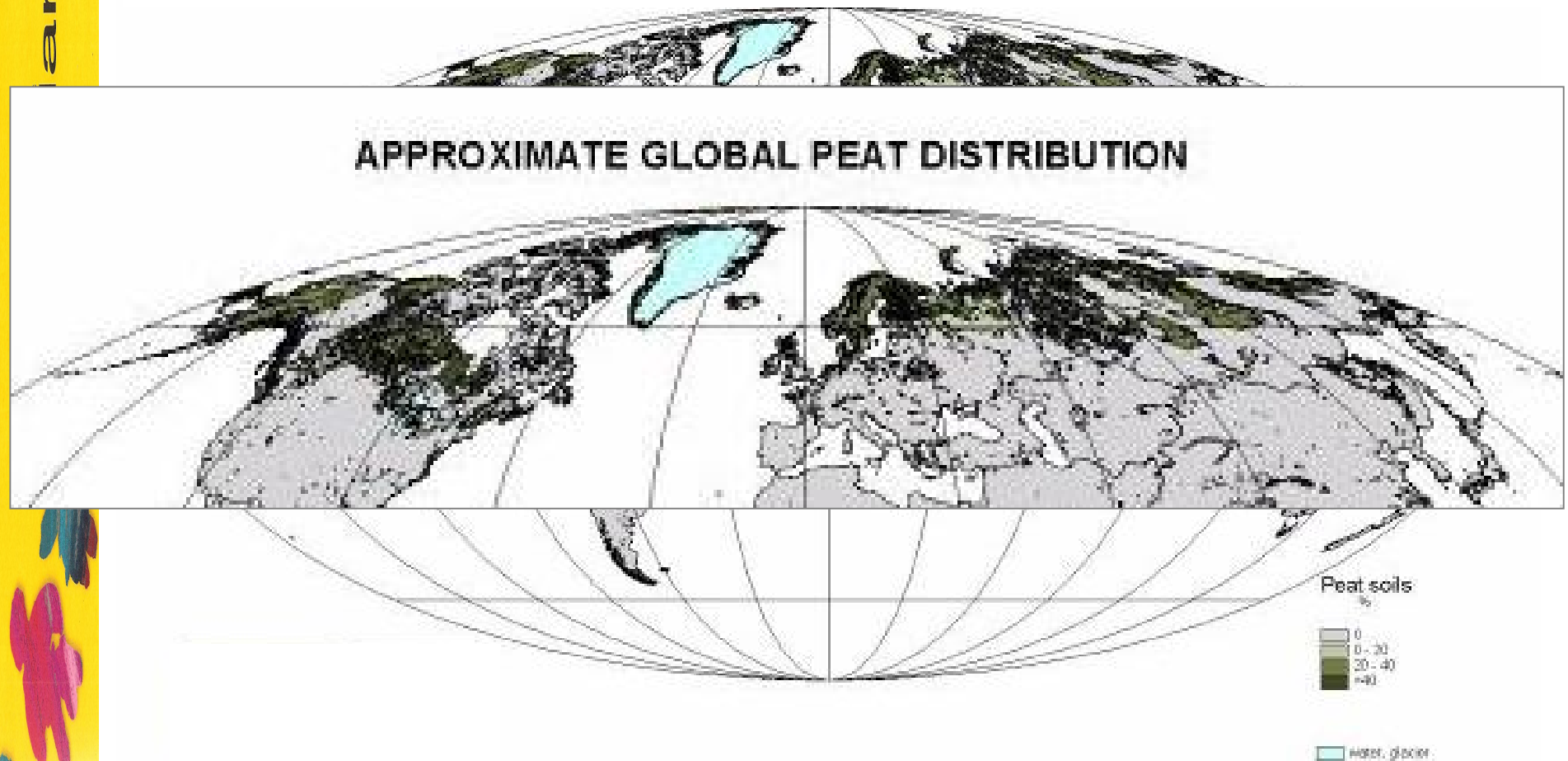


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# Challenges and solutions

## Global peat distribution:



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Source: Wetlands International



# ROADEX Roads on Peat

## 4 reports on the website:

- ROADEX II Report, 2005  
*"Dealing with Bearing Capacity Problems on Low Volume Roads Constructed on Peat"*
- ROADEX II Guidelines, 2005  
*"Guidelines for the Management of Peat Slips on the Construction of Low Volume/Low Cost Roads over Peat"*
- ROADEX III Executive Summary, 2006  
*"Managing Peat Related Problems on Low Volume Roads"*
- FCE/SNH Report, 2010  
*"Floating Roads on Peat"*



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# Roads on Peat - eLearning

## Contents:

- Peat
- Behaviour of peat
- Environmental considerations
- Geotechnical risk management
- Engineering considerations
- Investigations and surveys
- Construction of roads on peat
- Maintenance of roads on peat
- Monitoring
- Records



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The screenshot displays the ROADEX eLearning platform interface. At the top, there is a navigation bar with 'Home', 'About Us', 'Background', 'ROADEX Services', 'Demonstration Projects', 'Research Projects', 'ROADEX eLearning', 'Press', and 'Contact'. Below this, a sidebar contains a 'Get the latest ROADEX news' section with a 'Subscribe' button. The main content area is titled 'Lesson 1: Roads on peat' and includes a 'Contents' sidebar on the right listing topics like '1. Peat', '1.1. Introduction', '1.2. Organic soils', '1.3. Formation of peat', '2. Geotechnical risk management', '3. Engineering considerations', '4. Investigations and surveys', '5. Construction of roads on peat', '6. Maintenance of roads on peat', '7. Monitoring', and '8. Records'. The main content area shows the '1.1. Introduction' section, which discusses the importance of peat in the construction of roads and the need for careful management. It includes a video player showing a road construction site and a text box explaining the importance of peat in the construction of roads. The interface is clean and professional, with a green and white color scheme.



# Roads on Peat - Challenges and solutions

## Challenges:

Environmental:

- sensitive areas
- ecology & hydrology
- usually protected

Economic:

- reducing budgets
- increasing demands
- search for “best value”

Engineering

- weak subgrade
- high water table
- stability
- consolidation
- settlement
- traffic loadings

## Solutions:

Protect the existing environment  
“do no more harm”

Focus on the problem areas  
Target measures where needed  
Innovate

Understand the problems  
Employ risk management procedures  
Use “fit for purpose” structures



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# Environmental considerations

- Usually a protected area/ecology/habitat
- Sensitive to changes in hydrology
- Disturbance
- Pollution
- Construction
- Drainage



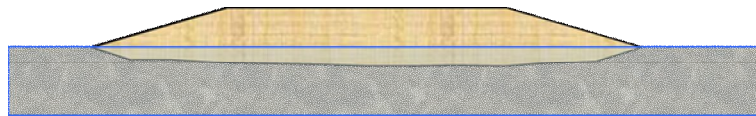
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BBC Scotland

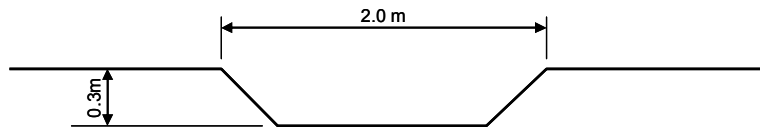


# Roads on peat considerations

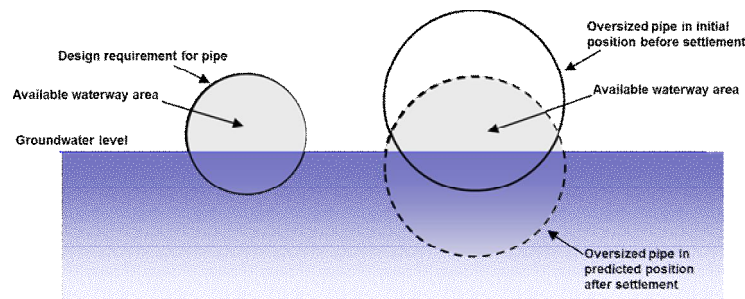
## Drainage/hydrology:



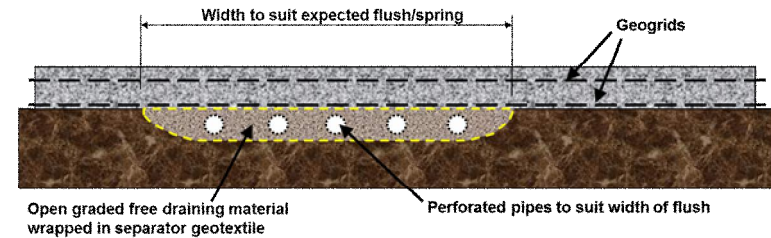
Floating road – no ditches



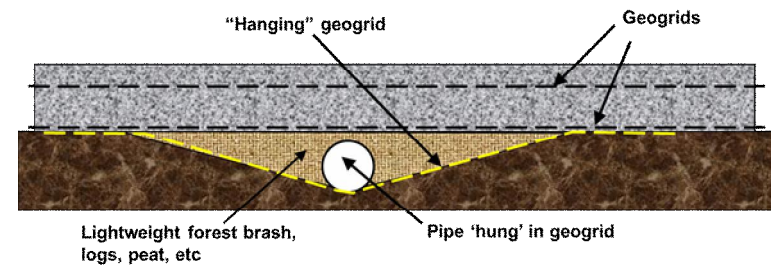
Shallow ditches rather than deep ditches



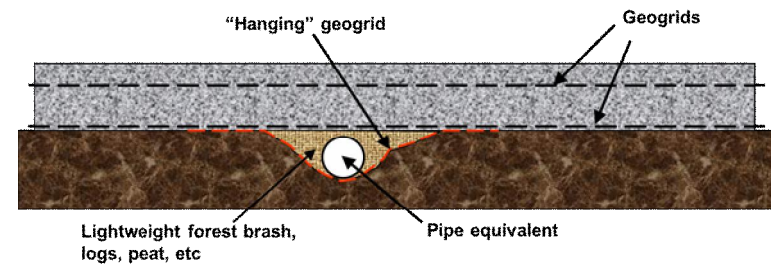
Oversizing culverts to permit settlement



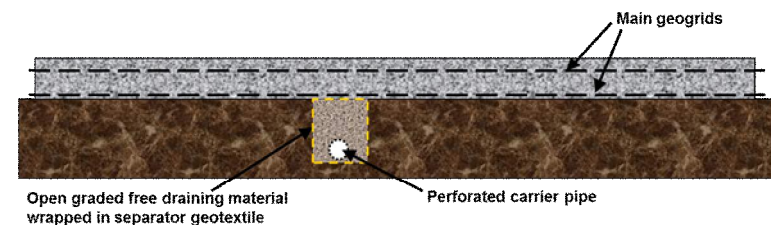
Dealing with surface flows of water



Hanging culvert in a geogrid



Hanging culvert in a geogrid



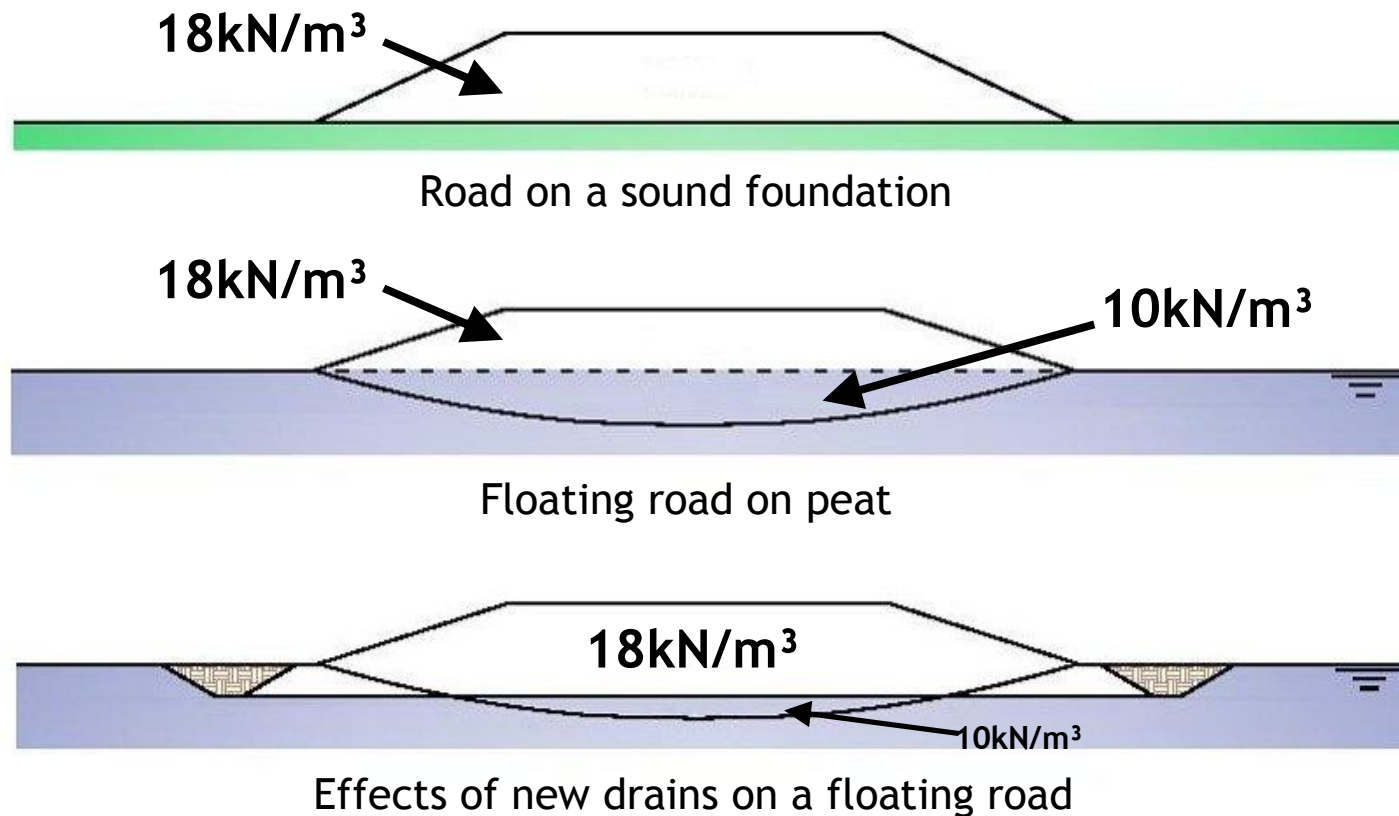
Stone filled ditch wrapped in geotextile



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# Drainage/hydrology - existing roads

## Buoyancy effects on peat



P Carlsten SGI



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# Economic considerations

- Class of road
- Design speed/tolerance
- Traffic loading
- Time and budget



**Multi-lane highway**



**Dual highway**



**Two lane road**



**Single track road**



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# Budget v. Timing:



**Advance earthworks ahead of road construction – add 3 years**



**Vertical drainage to speed settlement – add €€€€€**



**2-lane road in Iceland constructed by preloading – 1 year**



**Low volume wind farm road immediate loading by 150 tonne trucks**



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# Engineering considerations:

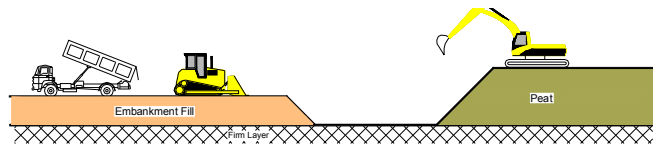
- predominantly water + dead plant fragments
- up to 95% water, moisture content up to 2000%
- variable shear strength, 2kPa to 40kPa
- subject to consolidation & compression
- leading to settlement & deformation

⇒ a challenging material for road construction

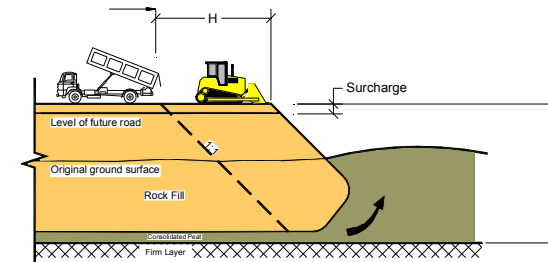


# Engineering considerations

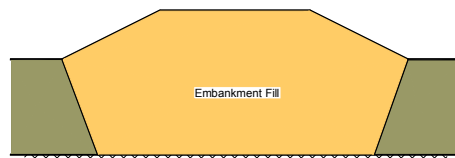
## Methods of Construction:



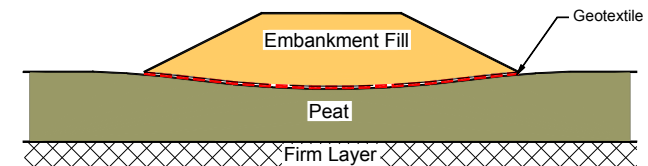
Peat excavation



Peat displacement



Peat replacement



Peat left in place



# Engineering considerations



**Work planning - excavation in winter  
when the peat is frozen**



**Excavation – what to do with  
the excavated peat?**



**Rehabilitation of road on peat  
Extra load = additional settlement**

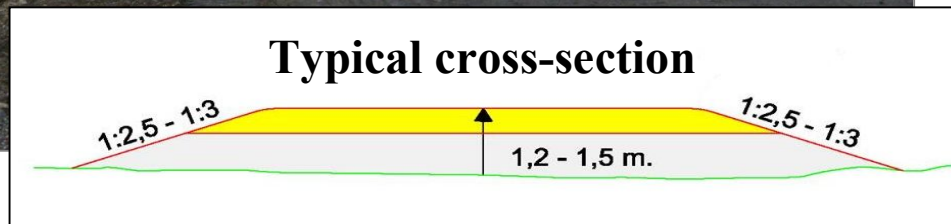


**Widening of road on peat  
How to make the new act like the old**



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# Case study: “Icelandic Preloading”

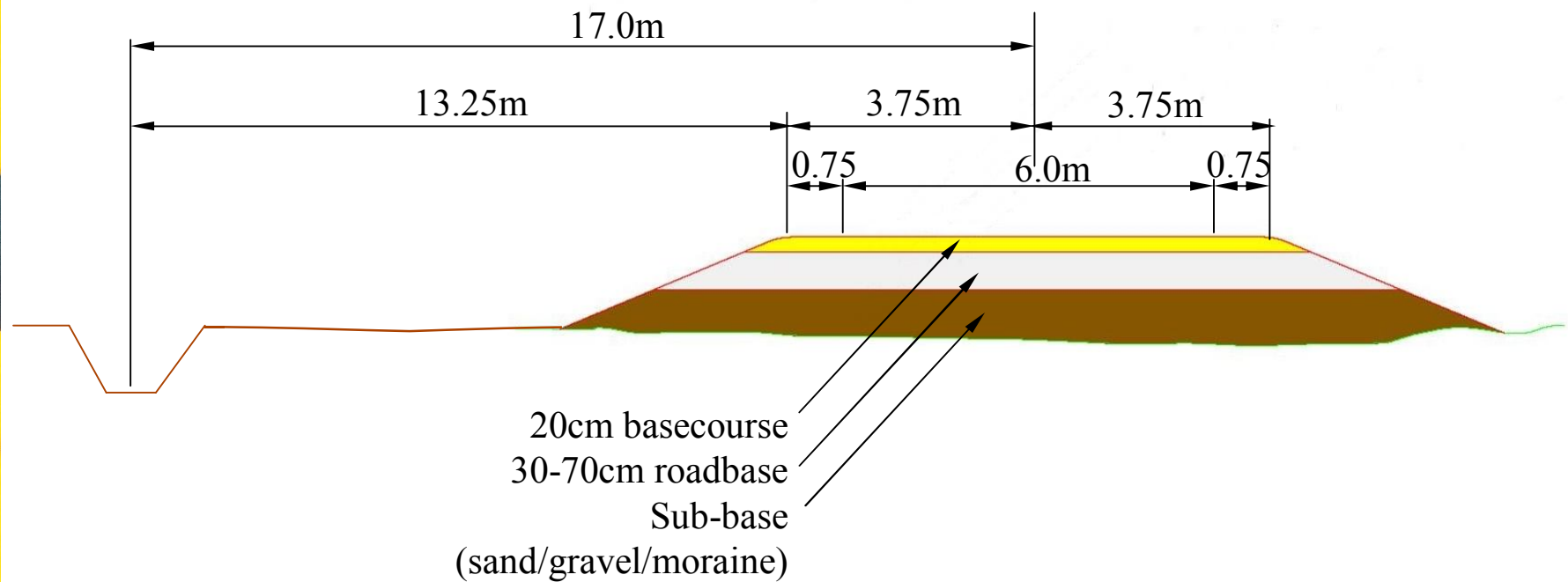


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# Icelandic preload method

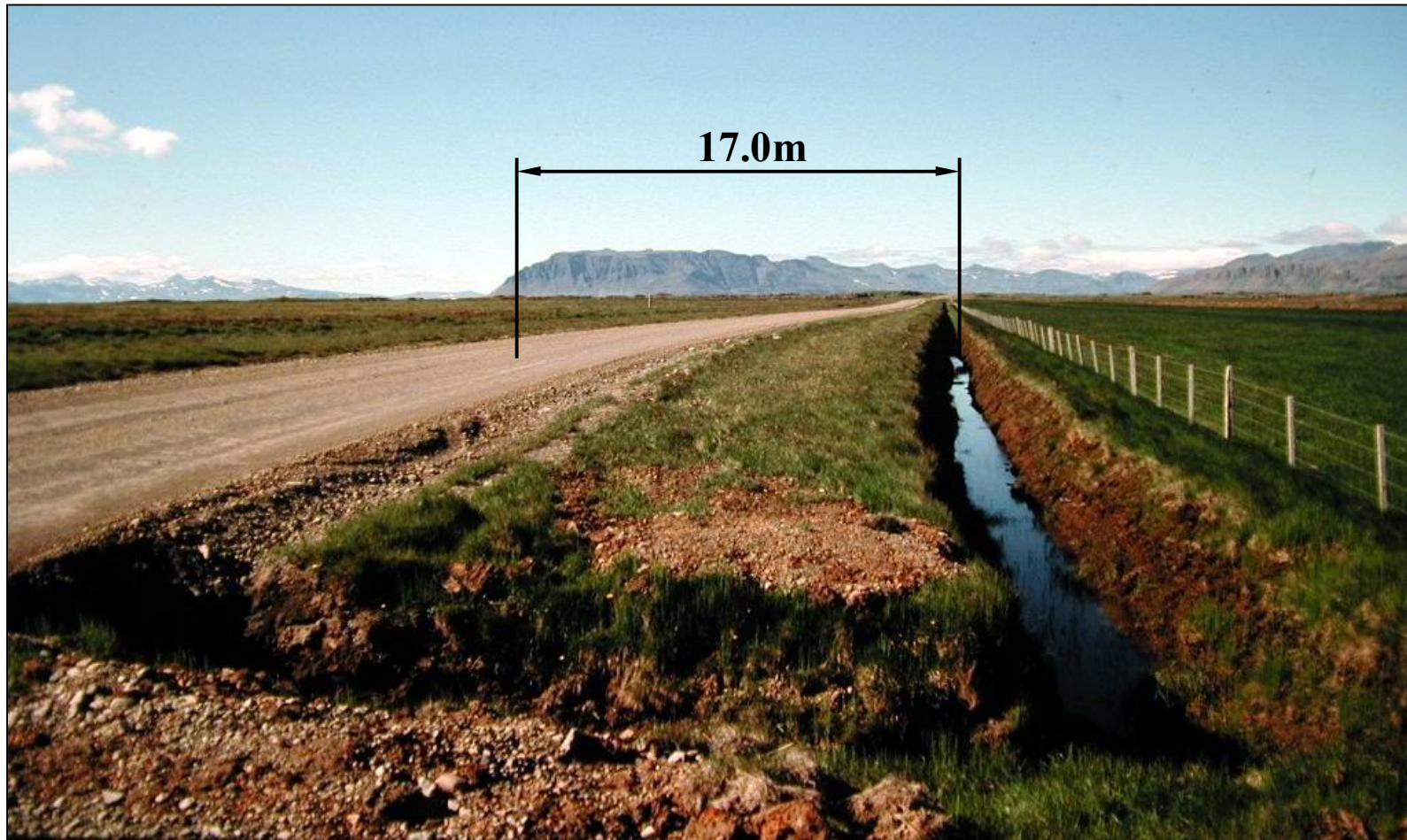
## 6.0m wide rural road



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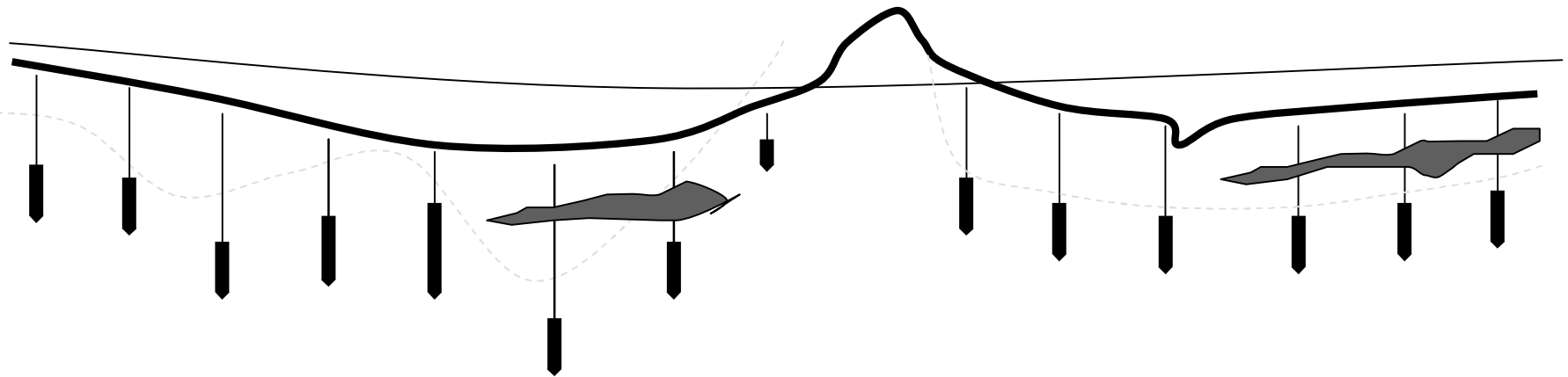
# Icelandic preload method

## Advance ditches



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# Icelandic preload method: Ground Investigation



Boreholes driven at 20 m intervals in peat areas

Drilling carried out using rotation and penetration at constant speed.

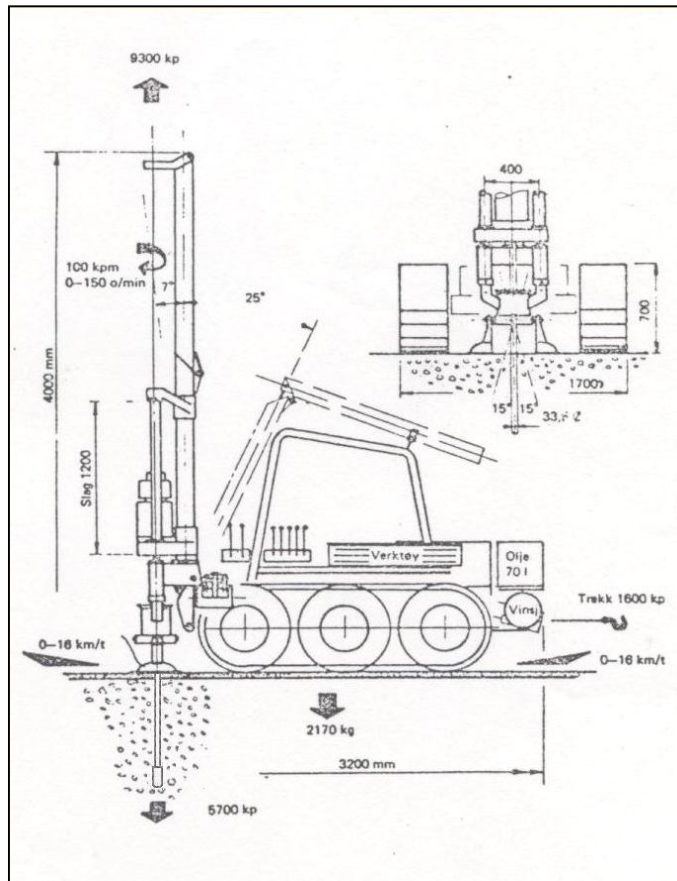
The force needed to push the probe down is logged.



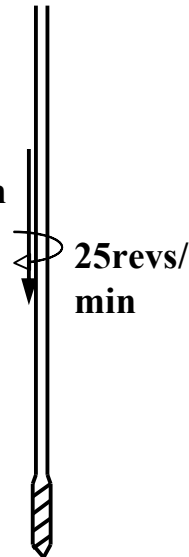
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# Icelandic preload method: Ground Investigation - drilling rig



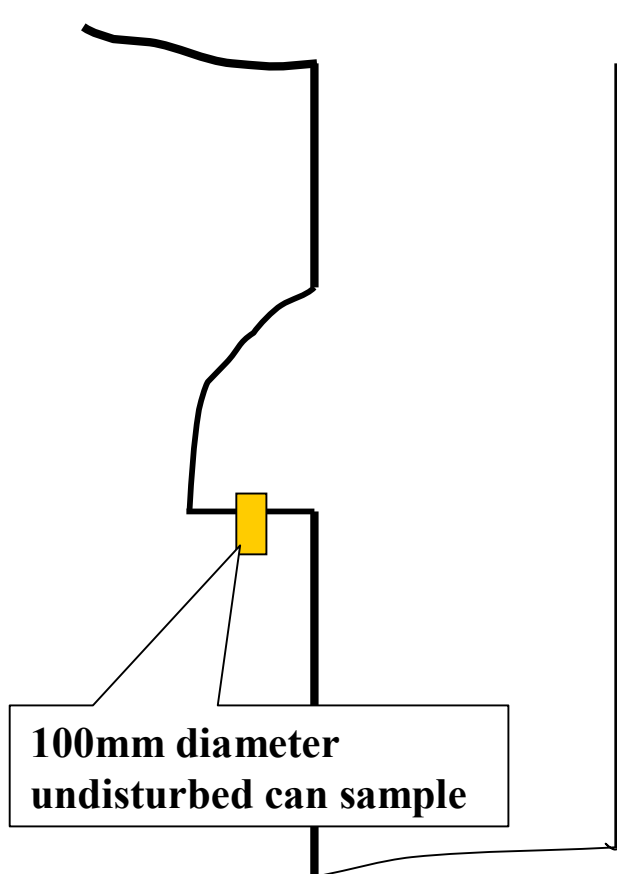
3m/min



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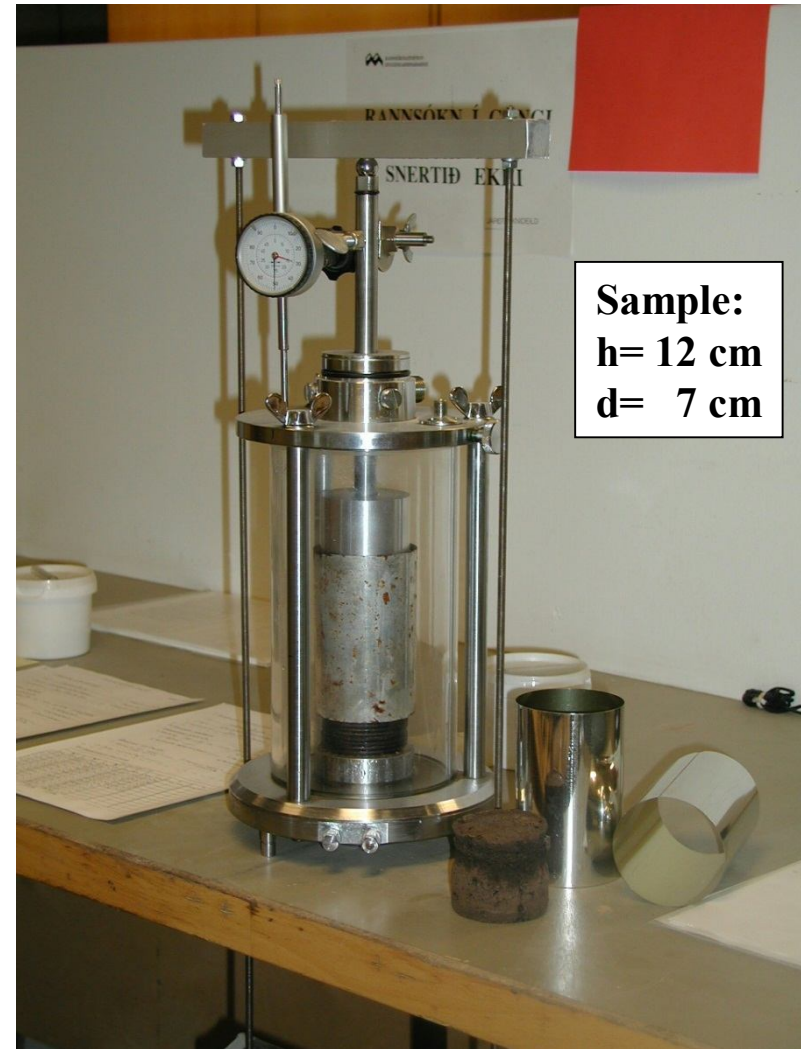
# Icelandic preload method: Ground Investigation - Undisturbed peat sampling



# Icelandic preload method: Laboratory testing

## Oedometer/compressiometer

$P_0$	Overburden pressure
$P_c$	Preconsolidation pressure
<input type="checkbox"/> $p$	Additional pressure
<input type="checkbox"/>	Total stress
$M$	Constrained modulus
$m$	Coefficient of volume change
$C_v$	Coefficient of consolidation
$r_s$	Shear stress
<input type="checkbox"/>	Density
<input type="checkbox"/>	Strain





# Icelandic preload method:

## Estimation of settlement - Janbu method

**Settlement calculated as an elastic material, during the preconsolidation stage ,  $P_c$ , as following:**

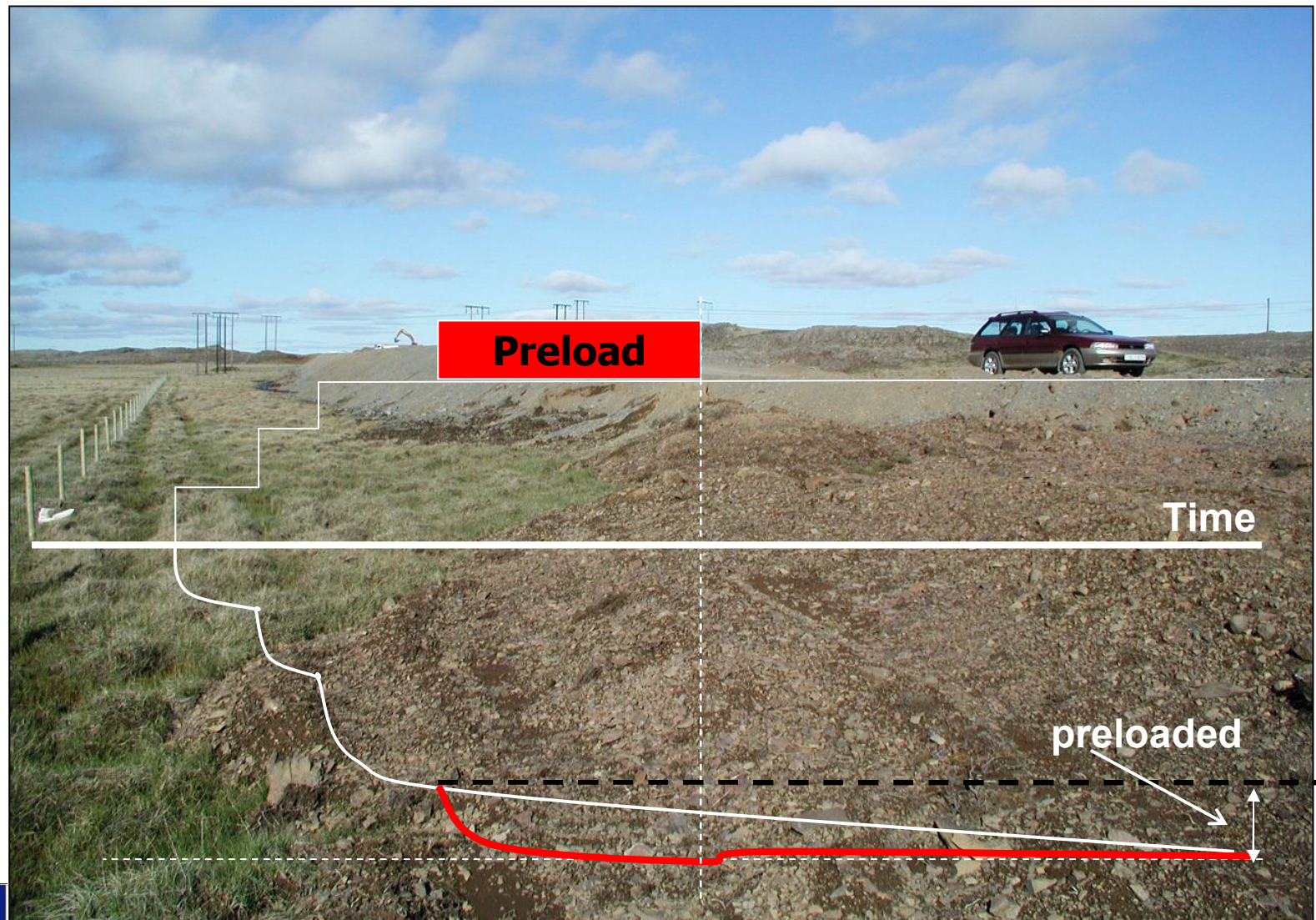
$$\delta c = \int_0^H \varepsilon dz \quad \varepsilon = \int_{P_0}^{P_0 + \Delta P} \frac{\bar{\sigma}}{M} = \frac{\Delta P}{M}$$

**When dealing with a virgin area:**

$$\delta c \int_0^H \varepsilon dz \quad \varepsilon = \int_{P_0}^{P_0 + \Delta P} \frac{\bar{\sigma}}{m * \bar{\sigma}} = \frac{1}{m} * \ln \frac{P_0 + \Delta P}{P_0}$$



# Icelandic preload method: Preloading Method



# Icelandic preload method

## Preloading Method - Predicted settlement summary table

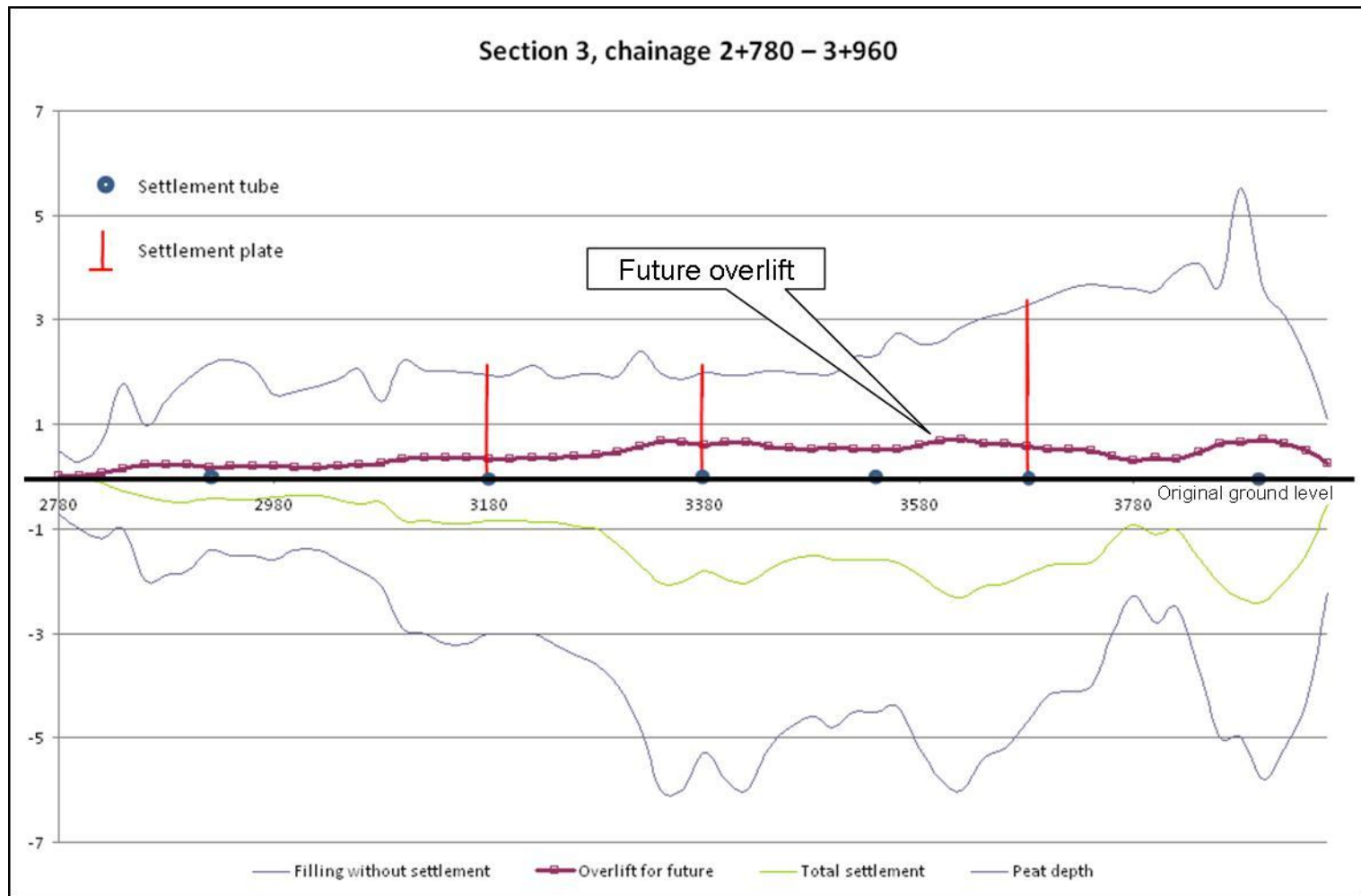
Road section														
510-01 Borgarfjarðarbraut to Vatnshamraleið														
Section M	Depth of Fill m	Depth of Peat m	Primary consolid m	Secondary compress m	Total settlement m	Preload m	Area m2	Volume m3	Cosolidation time in days				width increase m	Length of hose
									30%	50%	70%	90%		
9100	0.98	0.80	0.11	0.11	0.22	0.11	1.87	37.49	0.0	0.1	0.2	0.4	0.08	9.4
9120	2.32	1.40	0.40	0.15	0.55	0.20	6.02	120.41	0.1	0.3	0.5	1.2	0.30	13.5
9140	3.27	1.70	0.59	0.16	0.74	0.25	9.56	191.16	0.1	0.4	0.8	1.7	0.44	16.3
9160	2.77	1.50	0.47	0.15	0.62	0.21	7.40	148.06	0.1	0.3	0.6	1.3	0.35	14.8
9180	2.02	1.50	0.40	0.16	0.56	0.21	5.82	116.36	0.1	0.3	0.6	1.3	0.30	12.6
9200	2.02	1.20	0.31	0.13	0.45	0.17	4.67	93.37	0.1	0.2	0.4	0.9	0.23	12.6
9220	1.64	1.60	0.37	0.17	0.55	0.21	5.32	106.38	0.1	0.4	0.7	1.5	0.28	11.4
9240	1.69	2.90	0.77	0.26	1.03	0.36	10.12	202.35	0.4	1.2	2.3	5.0	0.58	11.6
9260	1.75	1.70	0.42	0.18	0.60	0.23	5.90	117.99	0.1	0.4	0.8	1.7	0.32	11.7
9280	1.05	0.50	0.07	0.08	0.15	0.08	1.26	25.17	0.0	0.0	0.1	0.1	0.05	9.7
9300	2.68	2.50	0.82	0.21	1.03	0.33	12.12	242.33	0.3	0.9	1.7	3.7	0.62	14.5
9320	1.42	2.90	0.70	0.27	0.97	0.36	9.00	180.00	0.4	1.2	2.3	5.0	0.53	10.8
9340	1.52	2.60	0.64	0.25	0.89	0.33	8.39	167.82	0.3	0.9	1.9	4.0	0.48	11.1
9360	1.43	2.90	0.70	0.27	0.97	0.36	9.04	180.85	0.4	1.2	2.3	5.0	0.53	10.8
9380	1.33	2.40	0.54	0.24	0.78	0.30	7.05	141.01	0.3	0.8	1.6	3.4	0.41	10.5
9400	1.56	2.40	0.59	0.23	0.82	0.30	7.88	157.52	0.3	0.8	1.6	3.4	0.44	11.2
					0.66	6450.98								



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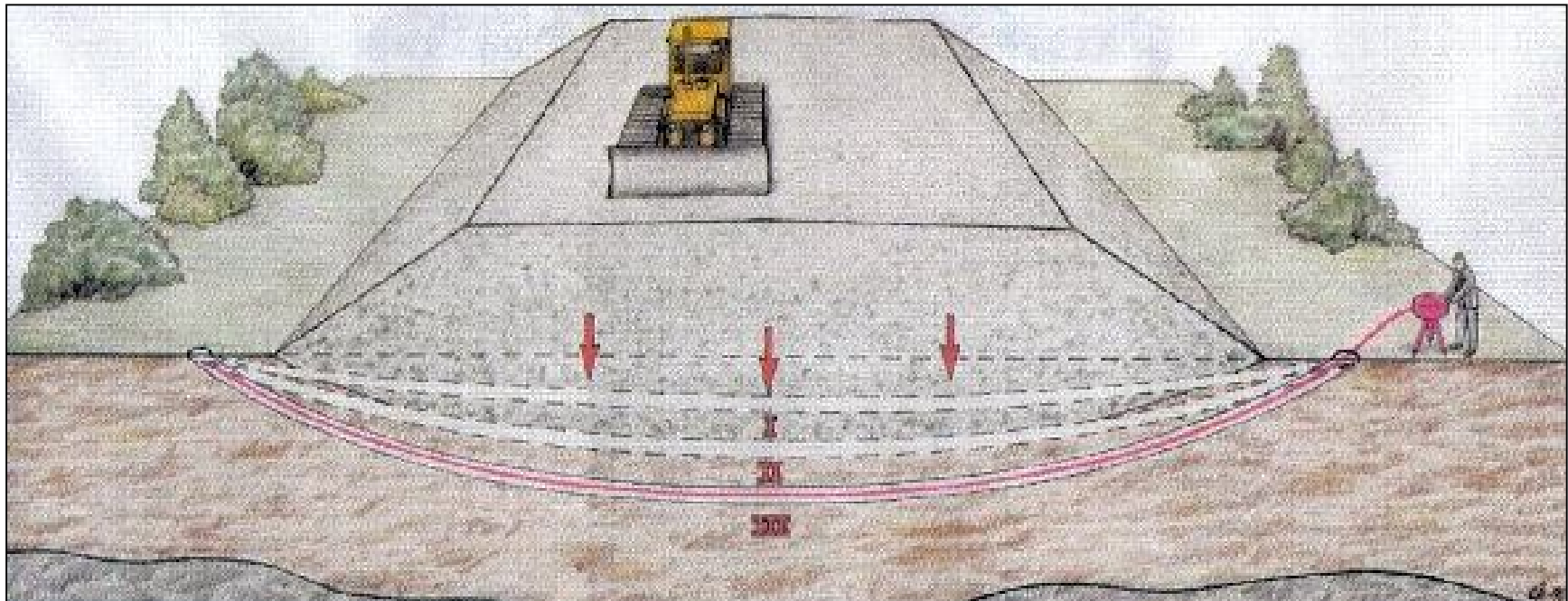
# Icelandic preload method: Preloading plan to force settlement



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# Icelandic preload method: Measurement of settlement by pressure sensor



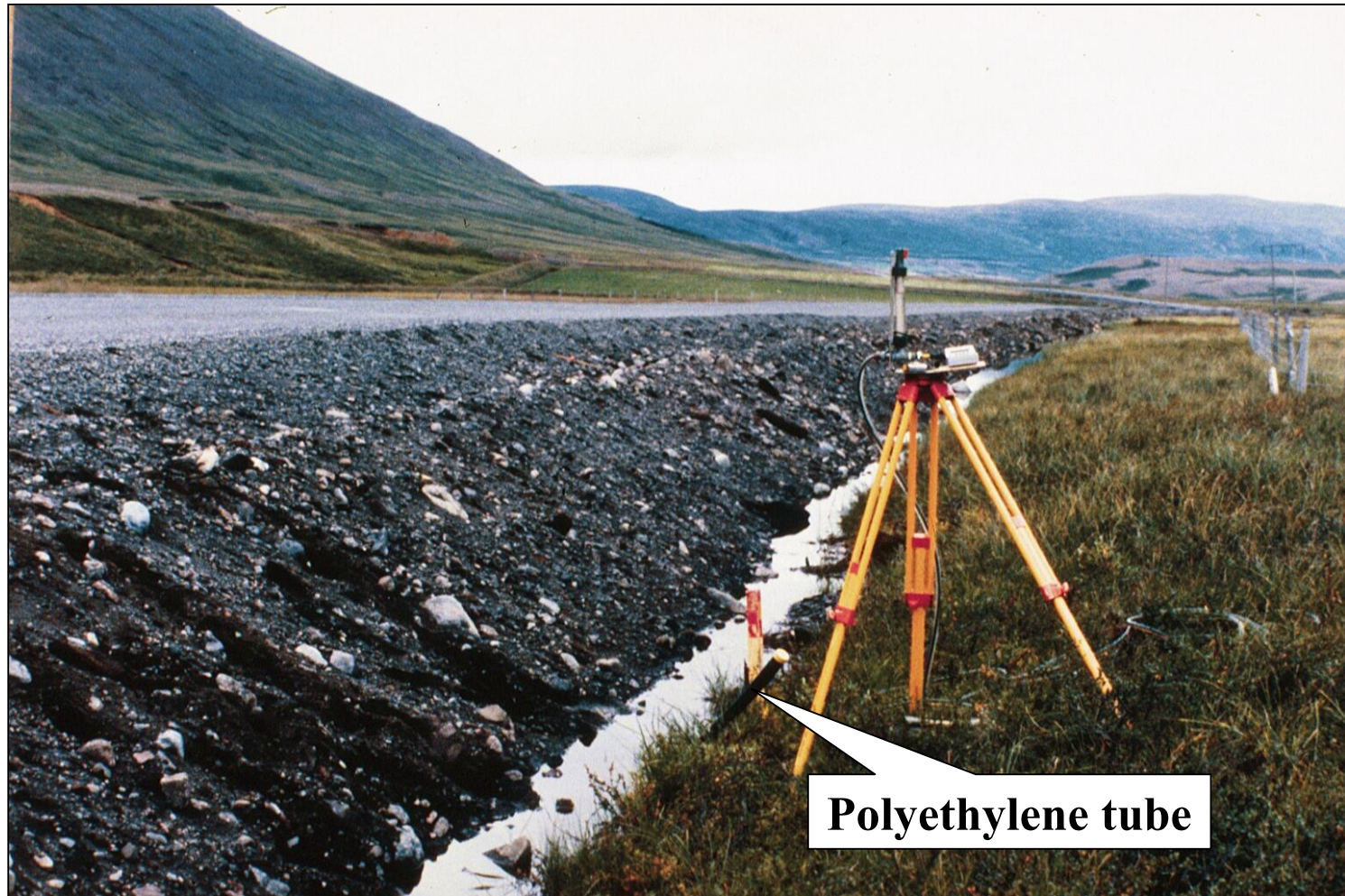
## CONSOIL Hydrostatic Profiler

- polyethylene tube with a portable pull-through sensor



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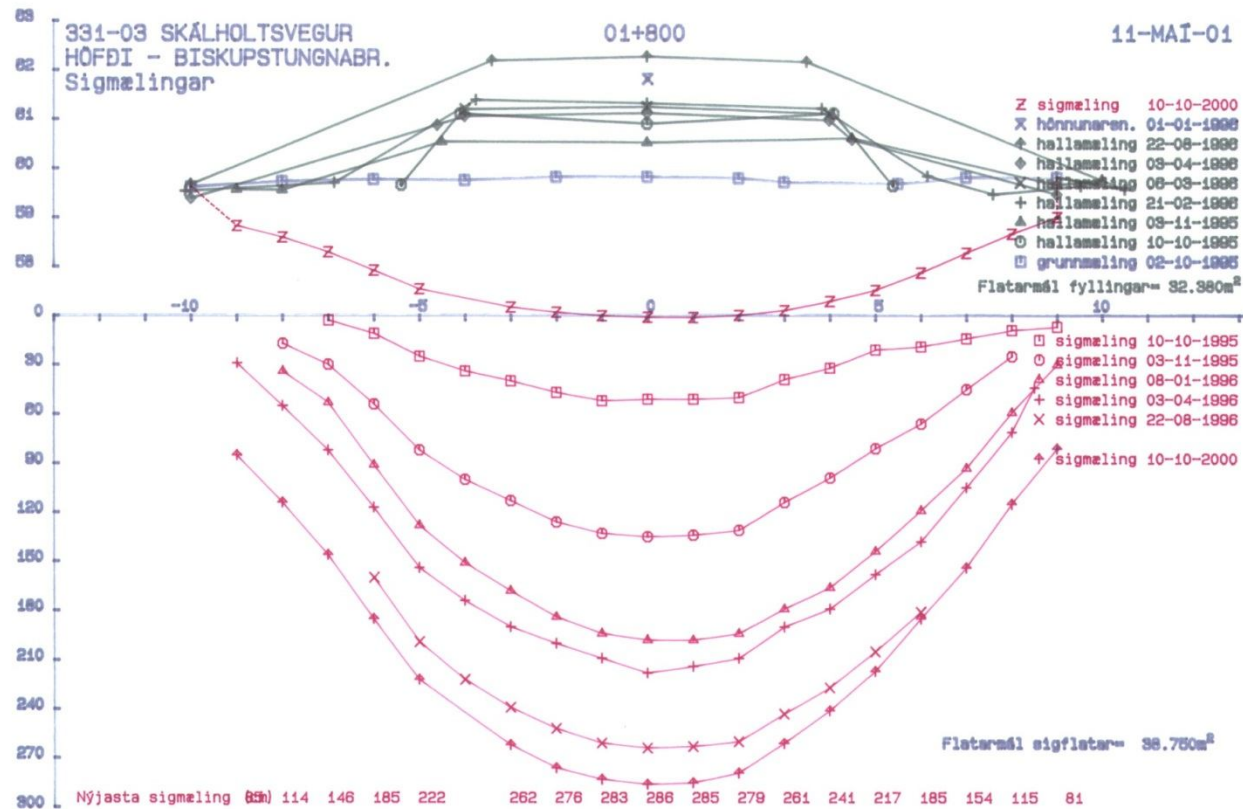
# Icelandic preload method: Measurement of settlement by pressure sensor



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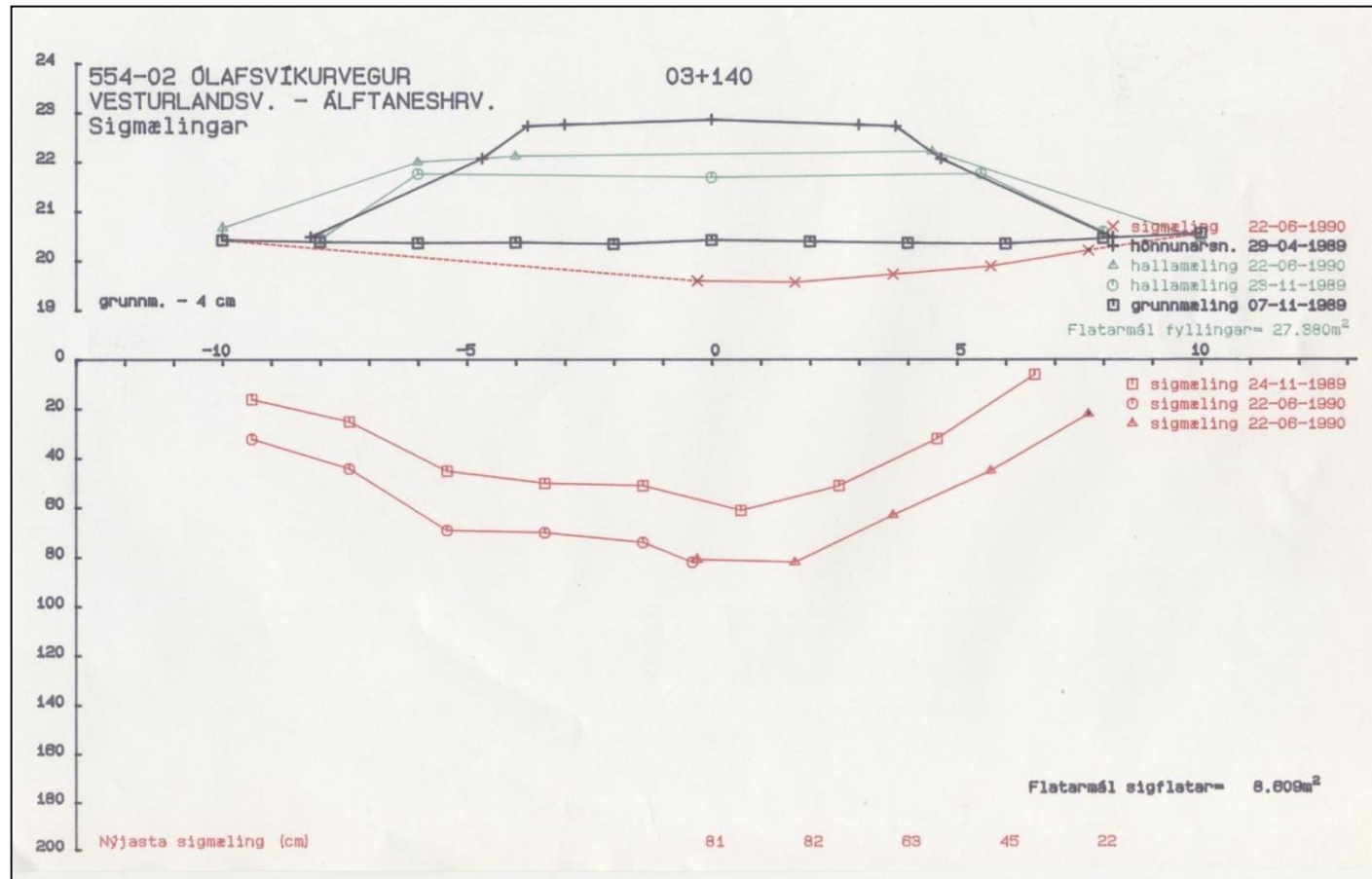
# Icelandic preload method: Time - settlement records



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# Icelandic preload method: Time - settlement records



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# Icelandic preload method: Tube installation



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# Icelandic preload method: Referencing tube on peat surface



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# Icelandic preload method: Referencing settlement rod



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## ROADEX recommendations:

- Identify the underlying problems through survey
- Understand the processes causing the problems
- Innovate - find 'fit for purpose' solutions
- Do no more harm
- Make records and share knowledge, even the failures!





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Thank you

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