D5 Roads on Peat (in Ireland)

ROADEX Workshop in Ireland
Carrick-on-Shannon, 27 October 2011
Task D5: Roads on Peat

Lead persons: Haraldur Sigursteinsson & Ron Munro

Task description:
To demonstrate ROADEX technologies on planned road rehabilitation exercises on roads over peat.
To give practical support to local road improvement projects to use the new ROADEX road design methodology for low volume roads on their road networks.

NPP demonstration locations:
Ireland (2 projects)

Bog rampart, Ireland
D5 Roads on Peat
Demonstrating ROADEX methods

3 reports:

- 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”
D5 Roads on Peat
Demonstrating ROADEX methods

The three phases:

- Map the weak sections of road and **FOCUS** in on them
- **Understand** the processes causing the problems
- **Innovate** - find new ‘fit for purpose’ structures and treatments
D5 Roads on Peat
Method:

DATA COLLECTION:

- Falling Weight Deflectometer (FWD)
  - bearing capacity of the road
- Drill core data
  - road structure verification & quality
- Digital video
  - pavement condition documentation
- Scanner
- Ground Penetrating Radar
  - road structures
  - subgrade soil quality
  - reasons for road defects

DATA PROCESSING AND ANALYSIS:

- ‘Road Doctor’ by Roadscanners Oy
- ArcView
D5 Roads on Peat (Ireland) - outline

Project plan:

- **Initial visit** by HS to make working contact and get an understanding of Irish conditions. Preparation of preliminary report on Irish best practice. Discuss how sharing could happen;

- **Identify demonstration project locations**, preferably one strengthening project and one widening project;

- **Survey with ROADEX methods** (FWD, GPR, GPS, video, scanning, etc) to identify the problem areas and formulate solutions. Surveys and interpretation paid by Partners;

- **Strengthening & widening of road sections on peat**. Settlement is a major issue in strengthening and widening roads over peat - to be addressed in ROADEX for the first time. ROADEX to assist in design.

- **Carry out works** by Contractor. Report by ROADEX.

Links with other Tasks:

- Input into eLearning task and road widening research for projects involving peat.
## D5 Roads on Peat (Ireland) - delivery

| November 2010 | DoT & NRA agree roads sections to be surveyed:  
|               | • N56 Drumnaraw to Cashelmore, County Donegal  
|               | • N59 Newport - Mulranny, County Mayo         |
| March 2011    | Survey of the road sections by PMS and Roadscanners |
| July 2011     | Submission of the preliminary reports and “Road Doctor” project files: |
| August 2011   | ROADEX workshop in Carrick-on-Shannon to discuss reports and give feedback  
|               | Follow-up                                     |
| March 2012    | Report                                        |
ROADEX - demonstration projects in Ireland

a) N56 Drumnaraw - Cashelmore, Co Donegal, (10km)
b) N59 Newport - Mulranny, Co Mayo, (15km)

Surveys March 2011:
- standard GPR survey in both directions
- deep GPR survey for presence of peat in both directions
- GPR cross-sections at selected locations
- laser scanner survey in both directions
- FWD survey in one direction at 50m centres
Roads on peat demonstrations in Ireland
Reports delivered 25 July 2011

N56 Drumnaraw to Cashelmore

N59 Newport to Mulranny
Example: N59 Newport - Mulranny

PAVEMENT AND STRUCTURE DEPTHS
N59 Newport to Mulranny
County Mayo
Example: N59 Newport - Mulranny

GIS map of SOFT SUBGRADE areas
N59 Newport to Mulranny
County Mayo
N59 Newport - Mulranny

TOTAL RISK CLASSIFICATION
N59 Newport to Mulranny
County Mayo
N56 Drumnaraw to Cashelmore

TOTAL RISK CLASSIFICATION
N56 Drumnaraw to Cashelmore
County Donegal
Today:
ROADEX workshop 27 October 2011
• Presentation of survey results
• Discussion
• Agree a way forward
• Report
Haraldur
D5 Roads on Peat

ROADEX workshop,
27 October 2011,
The Landmark Hotel, Carrick-on-Shannon
Site investigation
Boreholes are normally driven at 20 m intervals in peat areas. Drilling is carried out using rotation and penetration at constant speed. The force needed to push the probe down is logged.
Roads on Peat

N59 Mayo, 700m section of road on peat from 8150 to 8730
in the field
Roads on Peat

N56 Donegal, pocket of peat at Drumnaraw
and more, much more of something
Roads on Peat:
Ground Investigation - survey vehicle

- Speed: 3m/min
- Revolutions: 25revs/min
New Geotechnical drillrig

Tenders documents were opened 25th of Oktober
New Geothnical drillrig
New Geotechnical drillrig

The drillrig shall have at least 3 tons capacity with maximum weight 6 tons. The following researches and drilling methods shall be performable by the drillrig:

- Rotary/pressure drilling in soft soil (n. Dreietrykksondering).
- Cone Penetration Testing CPT
- Sampling with 54 og 76 mm Piston samplers
- Dynamik sounding (Swedish standard)
- Georock drilling, (n. Geosondering)
- Total soil/rock drilling, (n. Totalsondering), combinations drilling in soft soil and hard rock.
CPT drilling
CPT in Peat - result
CPT - soil classification

\[ q_t = q_c + u_2(1-a) \]

1. Sensitive fine-grained soil
2. Organic soil
3. Clay
4. Silty clay to clay
5. Clayey silt to silty clay
6. Sandy silt to clayey silt
7. Silty sand to sandy silt
8. Sand to silty sand
9. Sand
10. Sand to gravelly sand
11. Very stiff fine-grained soil
12. Overconsolidated or cemented sand to clayey sand

Flokkað út frá friction við borhulslu.
Roads on Peat:
Ground Investigation - Undisturbed peat sampling

75 mm diameter undisturbed can samples from different peat layers
Roads on peat:

Estimation of settlement - Janbu method

Settlement calculated as an elastic material, during the preconsolidation stage, \( P_c \), as following:

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

When dealing with a virgin area:

\[
\delta c = \int_0^H \varepsilon \, dz \\
\varepsilon = \int_{P_0}^{P_0 + \Delta P} \frac{\bar{\sigma}}{m \cdot \bar{\sigma}} = \frac{1}{m} \cdot \ln \frac{P_0 + \Delta P}{P_0}
\]
Soil properties

Stress in soil

\[ \gamma' = \gamma \]
Groundwater table

\[ \gamma' = \gamma - 1,0 \]

\[ P_c = P_0 + 4 \text{ t/m}^2 \]
Consolidation Behavior of Peat

- **Instantaneous Strain**: $\varepsilon_i$
- **Primary Strain**: $\varepsilon_p$
- **Secondary Strain**: $\varepsilon_s$
- **Tertiary Strain**: $\varepsilon_t$
Stress - strain path

- Virign area
- Preloaded
- P_c

Vertical strain
Roads on Peat:
Estimation of settlement - Janbu method

\[ M = \frac{d\sigma}{d\varepsilon} = \text{Constrained modulus} \]

\[ m = \text{Coefficient of volume change} \]
Comparison of Icelandic and Irish peat

- 100 mm/200 mm sampler
- 100 mm/100 mm sampler
- 75 mm/100 mm sampler
- 120 mm*40 mm/200 mm sampler
- CRS - 2,52 cm*2,0 cm
- Skálholtsvegur
- Hringvegur um Þjórsá
- Janbu (1970) lower limit
- Janbu (1970) higher limit
Calculation of settlement time

\[ C_v = 2.5 \text{ cm}^3/\text{min} \]
Settlement - time resistant

Forsenda reikninganna er tímamótsstaðan $R_s$ sem fall af tíma.

Tímamótstöðutalan $R_s$ breytist línulega en lítið eftir að álagið er komið yfir á jómfrúarsvæðið og því er valin ein tala fyrir langtímasigðið.
Calculation of settlement time

Sigtíminn ákvarðast af lekt, lektarleið og spennuástandi mýrarinnar. Lekt mýrarinnar er ákveðin með mælingum í ödometer og konsolideringstíminn, $t_k$, síðan reiknaður þannig:

$$t_k = T_p \cdot \frac{D^2}{C_v}$$

$Up = \delta_t / \delta_{t100}$

$Up =$ konsolideringsgráðan gefur sigið á einhverjum ákveðnum tíma, $t$, í hlutfalli við sigið fyrir tímann $t_{100}$

Í sigreikningum er yfirleitt reiknaður tíminn fyrir 30 - 50 - 70 og 90% af skammtímasiginu.
Secondary settlement

\[ H = \text{mýrardýpt} \]

- 25% next 19 years
- 75% in 1. year
Secondary settlement

67% á 1. ári
33% á næstu 19
Sig vegfyllingar - tími

After 320 days, settlement 2,62 m
After 1830 days, settlement 2,86 m
### Predicted settlement summary table

**Road section 510-01 Borgarfjarðarbráut to Vatnshamraleið**

<table>
<thead>
<tr>
<th>Section</th>
<th>Fill depth (m)</th>
<th>Peat depth (m)</th>
<th>Primary consolidation (m)</th>
<th>Secondary compress settlement (m)</th>
<th>Total settlement (m)</th>
<th>Preload (m)</th>
<th>Area (m²)</th>
<th>Volume (m³)</th>
<th>30% Preload increase</th>
<th>50% Preload increase</th>
<th>70% Preload increase</th>
<th>90% Preload increase</th>
<th>Width increase of hose (m)</th>
<th>Length (m)</th>
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Roads on Peat:
Predicted settlement
Extra lift of fill material

Due to settlement expected after the constructions period the height of fill material should be higher than designed level. This can be equal to the secondary settlement and even also partly from the consolidations settlement.
Roads on Peat:

Preloading
Preloading - culvert - avoid bumbing

Water drain from the peat into drainage canal under the culvert.
It is common that counterweight is needed to avoid failure crack in the peat.
on Peat:
Measurement of settlement by pressure sensor

CONSOIL Hydrostatic Profiler
- polyethylene tube with a portable pull-through sensor
on Peat:
Tube installation
on Peat:
Referencing tube on peat surface
on Peat:
Referencing settlement rod
on Peat:
settlement tube, no crushed rock around the tube
on Peat:

Measurement of settlement by pressure sensor

CONSOIL Hydrostatic Profiler
on Peat:

Measurement of settlement by pressure sensor

CONSOIL Hydrostatic Profiler
on Peat:
Time - settlement records
on Peat:
Time - settlement records

Initial settlement

After 320 days, settlement 2.62 m

After 1830 days, settlement 2.86 m
on Peat:
Settlement records

Assymetric preloading
on Peat: Settlement records
on Peat:

First the material are placed on the widening part

Get the unloaded area into same settlement sequence as the prealoded area.
on Peat:

Ready for base and pavement, waiting period
on Peat in Ireland:

escavation and refill with crushed material
on Peat:

widening of existing road, waiting period
on Peat:

widening of existing road, waiting period

1 m deep cutting
on Peat:

Unwoven fabric 150 gr/m²
Overlap length 0.5 m
On Peat, thin layer on geotextile, failure
Supporting layer from trees
on Peat:
on Peat:
on Peat:
and some cracks which we don’t have
in our work we meet lot of people
Takk fyrir

ROADEX workshop,
27 October 2011,
The Landmark Hotel,
Carrick-on-Shannon
D5 Roads on Peat

ROADEX workshop, Roadbuilding on Peat practice in Iceland
Dreietrykksondering

TOTALSONDERING

TOTALSONDERING

- Vurdering av jordgrund
- God bekvemmelighet
- Automatisk oppfølgning av nedbryting
- Avtakning av nedbryting
-utsadbning av jordgrund
- Automatisk registrering av bevegelser
- Kan sondere i alle jordtyper
- Ikke påvirket av vann
- Optimal informationsfattning fra sondering

- Fra sondertak
- Nedbryting
- Sondering
N56 Creeslough, Donegal  

(John McLaughlin, Director)

Local contact Brian Burke

• Typical structures outside towns:
  - 40mm SMA to Clause 942, 60mm of 20mm dbm
  - 3-10cm surface dressing, 10-30cm clause 804 crushed rock, subbase

• Typical structure inside towns is 20mm DBM

• Road structure is likely to change along the road from HRA, SD, SMA, DBM, etc

• Water cannot escape from the carriageway due to the verges. If there is water sensitive material under the road this will lead to a loss in bearing capacity