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NIA Project Registration and PEA Document

Date of Submission

Jul 2019

Project Reference Number

NIA_NGTO033

Project Registration

Project Title

Investigation into the Properties and Behaviour of Liquid Soil (LS) Technology

Project Reference Number

NIA_NGTO033

Project Licensee(s)

National Grid Electricity Transmission

Project Start

September 2018

Project Duration

0 years and 11 months

Nominated Project Contact(s)

Oliver Cwikowski

Project Budget

£128,000.00

Summary

Cement Bound Sand (CBS) is a standard backfill material which is frequently used to reinstate excavations associated with laying underground high voltage transmission cables. However, this backfill is unsuitable when higher ratings are required as it cannot adequately dissipate the additional heat generated by the conductor. As we seek to increase the amount of undergrounding and capacity of our transmission infrastructure, this is likely to become of increasing importance.

Liquid Soil (LS) has been identified as a potential alternative to CBS as it claims to have a relatively low Thermal Resistivity (TR), which would allow the heat to dissipate quickly through the material and enable higher rated cables.

LS is formed by using excavated native soil which is then processed together with additives, which allows it to become temporarily flowable. This means that once prepared it can be poured into the trench and around the Gas Insulated Lines (GIL) or cable. The material adheres closely to the cable or GIL and sets hard without the risk of air gaps forming, thus removing the need for the backfill material to be compacted.

However, LS has not yet been used in the UK. In order to deploy this backfill on the High Voltage (HV) transmission system we need to understand the material properties of the LS and in particular how it behaves under certain conditions in terms of moisture retention and the consequent impact on TR.

The project will consist of a literature review to identify any alternative flowable type backfills for potential use in an HV environment and an investigation into the specific properties and behaviours of this type of backfill to assess the suitability of flowable type backfill materials for use on the UK transmission system. Tests will also be undertaken to gain an understanding of the possibility of any potentially harmful ingredients from the backfill material leaking (leaching) into the surrounding environment, and an assessment of the propensity for long term shrinkage of the LS.

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

Cement Bound Sand (CBS) is a standard backfill material which is frequently used to reinstate excavations associated with laying

underground high voltage transmission cables. However, this backfill is unsuitable when higher ratings are required as it cannot adequately dissipate the additional heat generated by the conductor. As we seek to increase the amount of undergrounding and capacity of our transmission infrastructure, this is likely to become of increasing importance.

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Method(s)

The project will consist of a literature review to identify any alternative flowable type backfills for potential use in an HV environment and an investigation into the specific properties and behaviours of this type of backfill to assess the suitability of flowable type backfill materials for use on the UK transmission system. Tests will also be undertaken to gain an understanding of the possibility of any potentially harmful ingredients from the backfill material leaching (leaching) into the surrounding environment, and an assessment of the propensity for long term shrinkage of the LS.

Scope

This project will investigate the properties and behaviours of the LS product to determine whether it could be suitable for use on the National Grid HV system. The study will take the following approach to meet the project objectives:

1. A literature review will be carried out to identify any alternative temporarily flowable backfills with potential for use in an HV environment which might have similar properties and benefits that could be assessed using the same methods
2. Investigation into thermal-hydraulic transport through LS when formed from a variety of soil samples
3. Investigation to understand moisture migration in a variety of LS samples
4. Basic soil mechanics and concrete tests will be used to determine the fundamental properties of the material and to gain familiarity with its use.
5. Investigation into the coupled thermal-hydraulic behaviour of LS when formed from poorly-graded, coarse sand, which is likely to provide the most onerous test of its performance.
6. A demonstration to show the extent to which experimental results can be modelled numerically and the potential to model design scenarios (case studies) to explore the suitability of various metrics (including the 50°C isotherm) in predicting the merit of using a LS backfill material
7. Investigation into the propensity for leaching of the proprietary ingredients of LS using the Toxicity Characteristic Leaching Procedure (TCLP).
8. An assessment of the propensity for long-term shrinkage of LS, especially at the soil-cable interface by deduction from the results of the basic soil testing.

Objective(s)

1. To identify any flowable type backfill materials available with potential for use on the UK transmission system.
2. To gain an understanding of the basic properties of flowable type backfills, specifically LS, when formed from a variety of indigenous materials, to assess the suitability of this type of backfill material for deployment on the UK transmission system.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

This project will be deemed a success if:

1. We gain knowledge of available flowable type backfill materials
2. a quantitative assessment of the propensity for moisture migration through LS when subjected to heating is delivered
3. a qualitative assessment of the likelihood that LS will dry out is made
4. a quantitative assessment of the thermal resistivity of LS and its variation when subjected to heating, using worst-case scenario parameter values and the most challenging choice of indigenous material is delivered
5. a quantitative assessment of the TR of LS and its variation with water content across a range of indigenous materials is delivered.
6. we gain an insight into the possibility of leaching of ingredients of the backfill into the surrounding environment and the propensity for long-term shrinkage of LS.
7. the National Grid technical specification for backfills is updated to include temporarily flowable materials.

Project Partners and External Funding

n/a

Potential for New Learning

Currently we do not understand the properties and performance of temporarily flowable backfills. If the success criteria are met, we will gain new understanding of whether these materials can retain moisture and dissipate heat efficiently. This will increase our ability to assess the suitability of LS for deployment in a range of scenarios, particularly where higher ratings are required for underground electricity transmission.

Scale of Project

Desktop exercise, laboratory testing and modelling at a research facility.

Technology Readiness at Start

TRL6 Large Scale

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

The research undertaken will be carried out in the UK.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£128,000

Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

n/a

How the Project has potential to benefit consumer in vulnerable situations:

n/a

Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only)

If successful LS may be deployed to enable single cable per phase solutions rather than two due to the lower thermal resistivity of the LS which will allow higher ratings on the cable. The additional environmental benefits due to the reuse of native soil may make potential deployment attractive for a wider variety of schemes.

Please provide a calculation of the expected benefits the Solution

The result of a cost benefit analysis showed a range of costs for LS from £40/m³ - £58/ m³. Minimum costs will depend on a large project and optimum placing of production units, whilst maximum costs will be incurred when there is low volume and the production units are located some distance from the installation. Actual savings will therefore be site specific, but derive from savings in transportation costs associated with removing spoil and delivering backfill material and costs for getting rid of waste material.

This can be compared with an average baseline unit cost of £95/ m³ for standard CBS.

Based on a range of figures provided for LS installations in Europe and tendered costs of CBS for recent schemes, savings range from 45% - 62% dependant on the factors detailed above.

Please provide an estimate of how replicable the Method is across GB

This technology is applicable to most types of soil and can potentially be used for underground installations across the transmission system.

Please provide an outline of the costs of rolling out the Method across GB.

Implementation costs are relatively low as the product is commercially available. The product would need to be type registered for use on the UK transmission system. Specialist training would also be required for any resources undertaking the mixing process (~3 days) if this was to be undertaken in-house, or the supplier could be contracted to carry out the process.

Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 NIA Project must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System

Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

- A specific piece of new (i.e. unproven in GB, or where a method has been trialled outside GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system software).
- A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)
- A specific novel operational practice directly related to the operation of the Network Licensees system
- A specific novel commercial arrangement

RIIO-2 Projects

- A specific piece of new equipment (including monitoring, control and communications systems and software)
- A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven
- A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)
- A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology
- A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution
- A specific novel commercial arrangement

Specific Requirements 4 / 2a

Please explain how the learning that will be generated could be used by the relevant Network Licensees

If the outcome of the testing proves favourable the LS material could be deployed in a wide range of underground cable and GIL HV transmission installations by other TOs and DNOs.

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

This project fits within the Managing Assets - value area of the Electricity Innovation Strategy.

- Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

Is the default IPR position being applied?

- Yes

Project Eligibility Assessment Part 2

Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

We are not aware of any work undertaken in this area of research in the UK despite previous invitations to suppliers to offer alternative backfills. Search of the ENA website has not identified any NIA projects in this field.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

n/a

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

This project will investigate the thermal properties of a temporarily flowable backfill in order to assess its suitability for deployment as a backfill for directly buried HV transmission. This type of backfill has not been used before in the UK in this application and in order to deploy it we need to understand its ability to efficiently dissipate the heat generated by underground transmission assets.

Relevant Foreground IPR

n/a

Data Access Details

n/a

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

LS has potential environmental advantages as it reuses the native soil rather than importing special backfill materials. However the most commonly used backfill, CBS is adequate in most situations and therefore financial drivers are insufficient to justify significant investment in this research.

Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks(e.g. commercial, technical, operational or regulatory) associated with the project

The project should be funded through the NIA as there are potential environmental benefits which may be exploited if we can gain sufficient understanding of how a variety of samples of this material behave under a range of temperatures and conditions. Without the NIA funding we would be unlikely to pursue this research and consequently we risk being able to gain the potential benefits associated with flowable backfills.

This project has been approved by a senior member of staff

Yes