

Shell E&P Ireland Limited
CORRIB FIELD DEVELOPMENT PROJECT
REPORT

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ONSHORE PIPELINE
STONE ROAD SETTLEMENT ANALYSIS

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1 INTRODUCTION

1.1 General

This report should be read in conjunction with 'Corrib Onshore Pipeline - Additional Information Report, June 2009' by AGECE [1].

This note presents the results from Finite Element Analysis (FEA) modelling for the pipeline, when subjected to settlement of the stone road in which it is constructed. The analysis shows that the total stress within the pipeline remains within the allowable limits and a sufficient margin of safety is maintained.

1.2 Abbreviations

AGEC	Applied Ground Engineering Consultants
BGE	Bord Gais Eireann
FEA	Finite Element Analysis
JPK	J P Kenny Limited
LVI	Landfall Valve Installation
SEPIL	Shell E&P Ireland Limited

2 OVERVIEW

2.1 The Analysis Methodology

A load-displacement analysis of the onshore pipeline has been performed to assess the impact on the pipeline when subjected to settlement of the stone road. To ensure that the analysis is conservative, and thereby provides a sufficient margin of safety, the analysis has used the maximum displacement values provided by AGEC, corresponding to Case 1 [1].

Case 1 is summarised in Section 3.1 of this report below, however for a full description of Case 1, refer to the referenced report.

The model includes the complete length of pipeline within the peat areas, and the corresponding Case 1 displacements.

The displacements provided are at various distances along the pipeline route. These spacings vary between 2m and 300m. As the pipeline is routed through an area of no peat (and negligible settlement) into an area of peat (potential increase of settlement) it will do so with a gradual change from one settlement condition to another.

The FEA model has been intentionally built conservatively. The model includes changes in settlement which occur over short distances, which result in higher calculated stresses than would occur in a gradual transition from an area of no peat, to a peat area.

The FEA evaluation considers two scenarios:

- The first is settlement during operation when the pipeline is full of gas, and
- The second during the pipeline hydrostatic testing when the pipeline is full of pressurised water.

3 LOAD CONDITIONS MODELLED

3.1 Key Inputs

The following load conditions were analysed:

Load Conditions	1	2
Description	Operating (gas)	Hydrotest (water)
Pressure (barg)	144	504
Settlement Case⁽¹⁾	1	1

Note 1: This represents the settlement values provided by AGEC [1].

Settlement Case 1 is summarised in the following table:

Settlement Case (1)	
Parameter	Settlement (mm)
Minimum	0
Maximum	750
Average	236

For a full description of Case 1, refer to the AGEC report [1].

The model includes the two sections of the pipeline route which contain peat areas; the peat area within the Rosspport Commonage up to the upstream entrance to the Upper Sruwaddacon Bay crossing, and from downstream of the Upper Sruwaddacon Bay crossing to the Terminal.

3.2 Results

The results are presented in the table below. The table shows:

- the allowable stress according to the code,
- the maximum stress calculated by the FEA,
- the ratio of maximum calculated stress to allowable stress, and
- the chainage where this is located in the model.

Maximum Stress		
Load Condition	1	2
Description	Operating (Gas)	Hydrotest (Water)
Pressure (barg)	144	504
Allowable Stress (MPa) (**)	436.5	485
Maximum FEA Calculated Stress (MPa)	318	468
Stress Ratio as a factor of Allowable Stress.	0.73	0.96

(**) Code I.S. 328, clause 6.4.1 gives the equation for equivalent stress (von mises) and 6.4.2 which gives the allowable limits (see Table 3, page 20). These are 1.0 x SMYS for Construction and Environmental load combinations as applied for the hydrotest case and 0.9 x SMYS for the Functional and Environmental load combinations as applied for the Operating case.

The location for maximum stress occurred at chainage 88,134.

The AGECC report [1] notes that the reading at 88,134 is probably an anomalous reading. In the event that the displacement at chainage 88,134 is found to be anomalous, the results would be as presented in the table below:

Maximum Stress Excluding Anomaly at Ch 88,134		
Load Condition	1	2
Description	Operating (Gas)	Hydrotest (Water)
Pressure (barg)	144	504
Allowable Stress (MPa)	436.5	485
Maximum FEA Calculated Stress (MPa)	168	425
Stress Ratio as a factor of Allowable Stress.	0.38	0.88

4 CONCLUSION

The finite element analysis has used the maximum displacements (Case 1) provided by AGECC [1] for stone road settlement, under two conditions and over the two sections of pipeline which are routed through significant areas of peat (including the transitions to non-peat areas).

The model has been intentionally built conservatively. The model includes changes in settlement which occur over short distances, which result in higher calculated stresses than would occur in, a gradual transition from an area of no peat, to a peat area.

It should be noted that most settlement will occur during construction of the stone road prior to installation of the steel pipeline.

Any further settlement would take place during filling of the pipeline with hydrotest water. Therefore there would be minimal settlement, if any at all, after gas is introduced into the pipeline.

It is for these reasons that the results of the analysis are considered to be conservative.

The results show that, although highly unlikely, should settlement take place during hydrostatic testing, with the pressure in the pipeline intentionally increased to 504 barg, the calculated stress is within the allowable stress.

During operation, should potential settlement occur coincidentally with the maximum design pressure of 144 barg, then the results are also within allowable stress. It is noted that during daily operation the gas pressure will be below 144 barg (typically around 100 barg).

It is concluded that the onshore pipeline routed through areas of peat and installed in the proposed stone road would not be subject to potential failure of the linepipe due to the predicted worst case settlement of the stone road.

5 REFERENCES

1. AGEC Corrib Onshore Pipeline - Additional Information Report, June 2009