1. INTRODUCTION

- There are several situations in the design of offshore wind farms where the strength and deformation properties of the near-surface are important, e.g. design of wind turbine foundations, cabling and pipelines.
- For a typical North Sea site, in situ confining stresses at shallow depths (0 to 10m below sea bed) are relatively low (0 to 120kPa).
- Current design methods use constitutive models that require calibration against laboratory tests, undertaken at confining stresses appropriate to the design situation.
- Published, high-quality experimental tests undertaken on sands at low stresses are currently very limited and have yielded inconsistent results.

2. RESEARCH OBJECTIVES

- To develop our understanding of the constitutive behaviour of sands at very low stress levels and clarify the conflicting results seen in the literature.
- To provide a database of advanced, high-quality, drained monotonic and cyclic triaxial stress path tests, utilising local strain measurement devices and vertical & horizontal pairs of bender elements.
- To investigate the effect of the number of cycles, stress amplitude and cyclic stress path on the development of dynamic secant stiffness values.
- To review and compare constitutive models used in commercially available FEA software packages and assess their capability of modelling sands at low stress levels.

3. LABORATORY APPARATUS

Tests have been undertaken using an advanced dynamic triaxial testing system (DYNTTS) manufactured by GDS Instruments Ltd. The system comprises four principal components:

1. GDSLAB Software
2. Data Acquisition Digital Control System
   - Closed-loop feedback
   - Stress or strain controlled
3. Automatic Pressure & Volume Controllers (APCs)
   - 2MPa Capacity
   - Resolution = 1kPa
   - Accuracy < ±3kPa (0.15%)
4. DYNTTS
   - Freq. Range: up to 10Hz
   - Up to 100mm samples

4. SAMPLE PREPARATION

- 'Undisturbed' sand samples are expensive and difficult to obtain from the field.
- Test specimens have been reconstituted using the wet pluviation technique to simulate natural marine depositional processes.

5. PRELIMINARY RESULTS

Test Material: Leighton Buzzard 14/25 sand (fraction B)
- Yellowish brown, sub-angular to rounded, uniformly graded SAND

Test variables:
- Confining stress, σ’ = 50kPa; Relative density, D_r = 80%; OCR = 1.0; Stress path:

- In triaxial compression: ϕ’_{max(TXC)} = 44.1°; ϕ’_{str(TXC)} = 33.6°
- In triaxial extension: ϕ’_{max(TXE)} = 31.7°; ϕ’_{str(TXE)} = ?? (unable to determine)
- Significant barrelling/necking observed in compression/extension tests, respectively

6. SUMMARY AND CONCLUSIONS

- Compression test results agree well with published and empirically determined values.
- Extension test results unsatisfactory – method of enforcing uniform strains required.
- Enlarged, lubricated end platens required to reduce end restraint and improve uniform stress & strain distribution.
- Higher-accuracy components required for future tests at confining stresses < 50kPa.