

FOUNDATIONS

UNSEEN, BUT FUNDAMENTAL TO ALL CONSTRUCTION

By PETER CONSTANTINE

SOUTH BUCKS U3A

6 November 2025

**SURGEONS BURY THEIR
FAILURES**

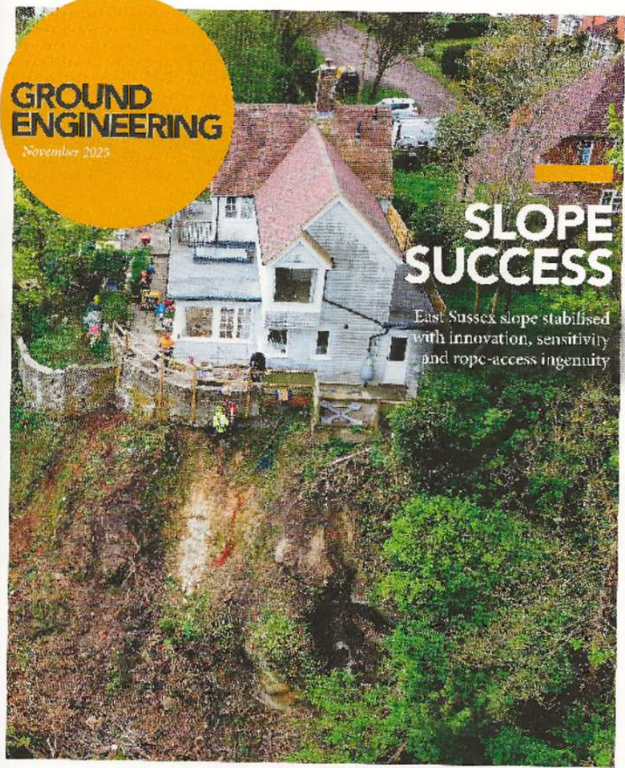
**GEOTECHNICAL
ENGINEERS BURY THEIR
SUCCESSSES**

GROUND ENGINEERING

NOVEMBER 2025

GROUND ENGINEERING

November 2025



SLOPE SUCCESS

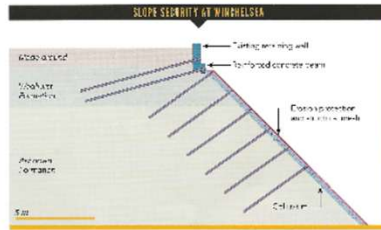
East Sussex slope stabilised with innovation, sensitivity and rope-access ingenuity

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LANDSLIDES
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Cable burial risk assessments drive down costs on an off-shore wind farm project in Scotland



The project required the wall reinforcement to be constructed entirely by rope access

The Sigma mesh and temporary head plates were erected above the rope-access installers. "You put the head plate on, and they access on like the rope team, but their first time," says Morris. "Some of the other systems take a bit of manual dexterity. These just require"

While the installers agreed that the lighter rolls reduced manual handling risks, they found that narrower sections also meant an increase in weight on the tripod system.

PROGRAMME AND COSTS
The works followed a tight programme. With the ground investigation starting in August 2024, the design team completed its work by the following February. This allowed Kier & James to mobilise to start work in April and reach substantial completion by August 2025.

"The survey and design phase cost around £1,000, with construction costing nearly £250,000. For the time design, as well as the additional, the total project value came to about £150,000."

When a hospital was unable to set up a station, Kier & James used a rope access, which means below the site, the stabilised slope is visible but not covered by mesh, with making a full and good job. The innovative visual impact of sprayed concrete has been considered, while structural stability is secured.

"The client was keen to get a look at a wall from the top of the slope," says Morris. "The ideal finished product is that you don't see it a tree or three years after the installation."

For anyone in low areas, the ground and foundation protected and de-risked to respect the heritage landscape of Windholse.

HISTORICALLY SIGNIFICANT COASTLINE

The area known as Windholse was once one of the small, coastal, historically significant "cottage port" towns. Between the 17th and 18th centuries, these towns provided men and a public coast of the English Channel to receive for legal and fiscal revenues, as well as to trade commercial goods and social events.

A very important town at the time, its coastline was formerly at the foot of the hills where the slope stabilisation project was required. However, reclamation, which provided for land that leads to Windholse beach, has left a rocky, flat area, now being managed with flood defences.

NEWS

'Sinkhole' on Lancashire estate linked to sandstone workings, MRA reports



The base of the collapse is approximately 32m in depth, indicating that it is a feature related to former sandstone workings of the Darwen Flags in the area

Mineral Resources Authority (MRA) investigators indicate that a large ground collapse on a housing estate in Darwen, Lancashire, may be related to former sandstone workings and is "not the result of natural soil erosion".

The ground collapse on 21 September engulfed an area of eroded soil in front of houses on a recently developed housing estate. Emergency services led by Blackburn and Darwen Borough Council secured the area, and some nearby homes were evacuated as a precaution.

The estate, developed by Tilia Homes, is built in an area with a known history of coal mining activity. Flouting documents from 1913 had flagged the land as "high risk" due to the presence of former coal mining features, including three mine shafts within 20m of the site boundary.

The MRA, now operating as the Coal Authority, initially objected at the development because the plot was to be built directly above a reworked mine shaft. In its consultation response to the council, the MRA said: "An unobstructed mine shaft and its resultant zone of influence pose a significant risk not only to surface stability but also public safety."

However, the development was approved

by Blackburn and Darwen Borough Council in 2021 after Tilia Homes provided evidence that the shafts had been properly capped and permitted by the MRA. The site layout was also amended to avoid direct construction over known mine entries.

Following these changes, the MRA removed its objection, and construction proceeded.

In the wake of the collapse, the MRA, as a category 2 responder, worked closely with Blackburn and Darwen Borough Council and Tilia Homes to investigate the cause of the sinkhole and stabilize and fill the hole.

The MRA's initial investigations in September showed evidence of historical mining in the area.

But the authority later said that "extensive ground investigations" had found that the sinkhole was not caused by historical coal mining. The depth of the collapse and area that it is related to a former sandstone mine.

It said: "Based on the records from our ground investigations at Cecce, Fields, Darwen, we have found that the base of the collapse is approximately 32m in depth.

to former sandstone workings of the Darwen Flags in the area, considering deep records from historical investigations."

The Darwen Flags is a fine-grained, micaceous, cross-bedded sandstone that is up to 4m thick, according to a British Geological Survey report.

The MRA confirmed that responsibility for the ground collapse was a result of sandstone workings.

In a statement to the press, Tilia Homes said: "An excavation area remains in place around the affected area under the control of the MRA, and to date no third parties - including Tilia Homes - have been permitted to undertake any investigation or remedial works within this zone."

"All parties are currently awaiting the full results of the MRA investigation. As access areas to other sites are governed by the MRA process, we will identify and communicate next steps along its partner agencies once the necessary information is sent to them."

"In the interim, alternative temporary traffic management solutions to support access to the 'from the door' options are actively being explored."

INTRODUCTION

- **FOUNDATIONS**
 - What do Foundations do
 - Different Types of Foundations
- **SITE INVESTIGATIONS (SIs)**
 - Determine Ground Conditions beneath the Site
 - Provides parameters for foundation design
- **GROUND IMPROVEMENT**
 - Ways of Improving Carrying Capacity of Poor Ground Conditions
- **FOUNDATIONS IN BEACONSFIELD**
 - Solution Features in Chalk
 - Buildings near to Trees

FOUNDATIONS (1)

- INTERFACE BUILDING/GROUND
 - Work like a mattress to spread load
- DESIGNED TO SAFELY SUPPORT THE STRUCTURE
 - Spread the building loads onto ground to reduce and even out the Intensity of Loading
 - Control total settlement within acceptable limits
 - Control differential settlement across the building
- GENERALLY ACCEPTED LIMITS FOR SETTLEMENT IN UK
 - Total settlement – Typically 25mm for most structures
 - Differential settlement – 10mm
 - Other buildings more sensitive, others more tolerant
- EXTREME CONDITIONS
 - Over the last 100 years Mexico City has settled a total of 8m
 - Mexico City is located on an old lake bed with highly compressible soils to 100m
 - Settlement caused from water extraction from Aquifers beneath the city
 - Additional settlement from building loads
 - Early Tower Blocks settled one storey into the ground in their lifetime

FOUNDATIONS (2)

- **SHALLOW FOUNDATIONS**
 - Less than 3m deep
 - Pad or Strip Foundations constructed with concrete
 - In open excavations
 - Depths limited by collapse of sides of excavations or by groundwater
 - Raft Foundations
 - Early Tower blocks in London were supported on Balanced Rafts foundations
- **DEEP FOUNDATIONS**
 - Piles – Typically 10-25m but can be 50m deep
 - Bored or Driven
 - Resistance from Side Friction and End Bearing
 - Shard – Tallest building in UK at 310m – 50m long piles up to 2m in diameter
 - Burj Khalifa – Tallest in World at 830m – 50m supporting 500,000 Tons
 - Petronas Tower, Kuala Lumpur – Deepest Piles at 120m, nearly 400 feet

SHALLOW FOUNDATIONS - TRENCH FILL



BORED PILE FOUNDATIONS



HAYES BYPASS

BORED PILE (CFA) FOUNDATIONS



DRIVEN PILE FOUNDATION



PRECAST
FACTORY
UNITS



CHOICE OF TYPE OF FOUNDATIONS

- **TYPES OF BUILDING STRUCTURES**

- Houses
- Tower Blocks
- Warehouses

- **BUILDING LOADINGS**

- Dead Loads – Weight of construction materials
- Live Loads – Weight of contents – Obtained from Design Codes
- Wind Loads – horizontal forces

- **GROUND CONDITIONS**

- Allowable Strength determines Dimensions of Foundations

FOUNDATIONS (3)

- **OTHER TYPES OF STRUCTURES**
 - DAMS – Built with Concrete or Soil - Water pressures
 - ROADS – Wheel and axle loads spread through formation
 - BRIDGES – Foundations maybe under water
 - OFFSHORE WIND TURBINES – Deep water
 - TRANSMISSION TOWERS – Very light but large horizontal cable forces

FORTH ROAD BRIDGE



2017

QUEENSFERRY CROSSING

NEW FORTH ROAD BRIDGE



SITE INVESTIGATION (1)

- **BUILDING STRUCTURE**
 - Constructed of Brick, Concrete or Steel
 - Good Quality Control of Materials
 - Often Manufactured in Factory Conditions for Pre-Cast units
 - Confidence in strength and quality of all building materials
- **GROUND CONDITIONS**
 - Dependent on Geology
 - Variable across site
 - Can comprise Sand, Clay or Rock, possibly all present across one site
 - Areas of soft or loose materials may be present on site
 - May be contaminated and contain man made waste materials
 - Groundwater variations

SITE INVESTIGATION (2)

• SITE INVESTIGATION

- Establish Information about conditions on site
 - Physical
 - Chemical
- Ideally allow cost of 1% of contract value – often much less is spent
 - More spent on Investigation = Less unknowns
 - Unknowns cost more and cause delays
 - Unknown Contamination could have major implications

• DESK STUDY

- Geological and Historical Maps
- Consult Authorities
 - EA
 - EHO
 - Building Control

SITE INVESTIGATION (3)

- **DESIGN APPROPRIATE INVESTIGATION**
 - Scope number of test locations and their depths
 - Target where new buildings planned
 - Target around any previous construction for contamination
 - General cover across site
- **UNDERTAKE INVESTIGATION**
 - Trial Pits with Excavator
 - Boreholes with Drilling Rig
 - Penetration Testing – Static, Dynamic
 - Geophysical Investigation – Electrical, Magnetic, GPR
 - Field Testing – Loading Tests
 - Laboratory Testing
 - Reporting

SITE INVESTIGATION – SOIL BOREHOLES



DUBAI SMELTER



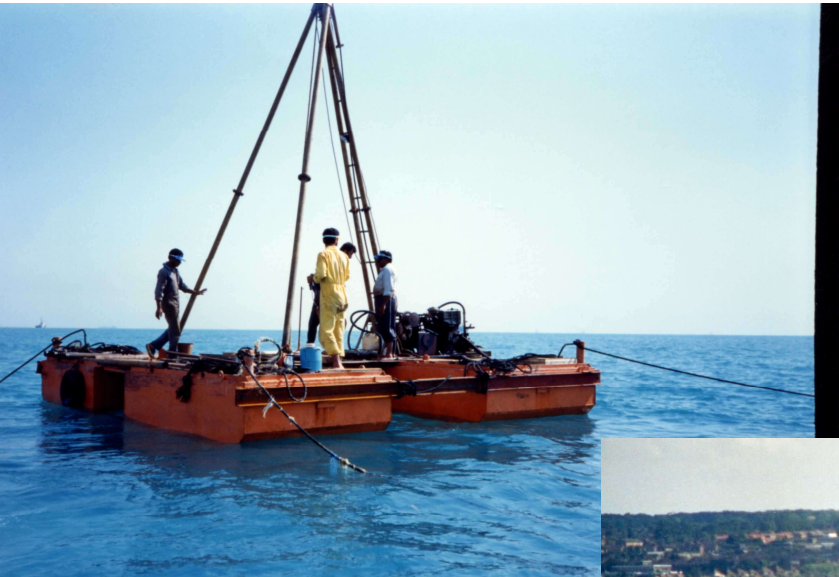
HAYS WHARF, RIVER THAMES

SITE INVESTIGATION – ROCK BOREHOLES



IRAN SMELTER

SITE INVESTIGATION – OFFSHORE BOREHOLES

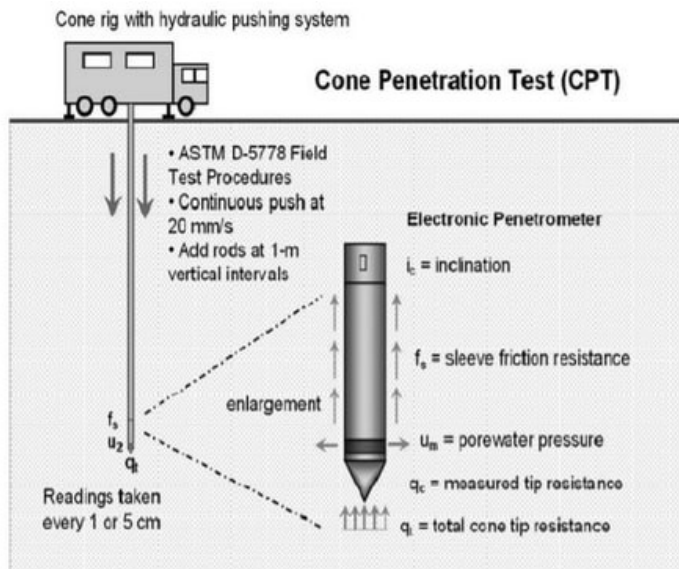


IRAN SMELTER



KINGSNORTH
POWER STATION

SITE INVESTIGATION – PENETRATION TESTING (1)



SITE INVESTIGATION – PENETRATION TESTING (2)

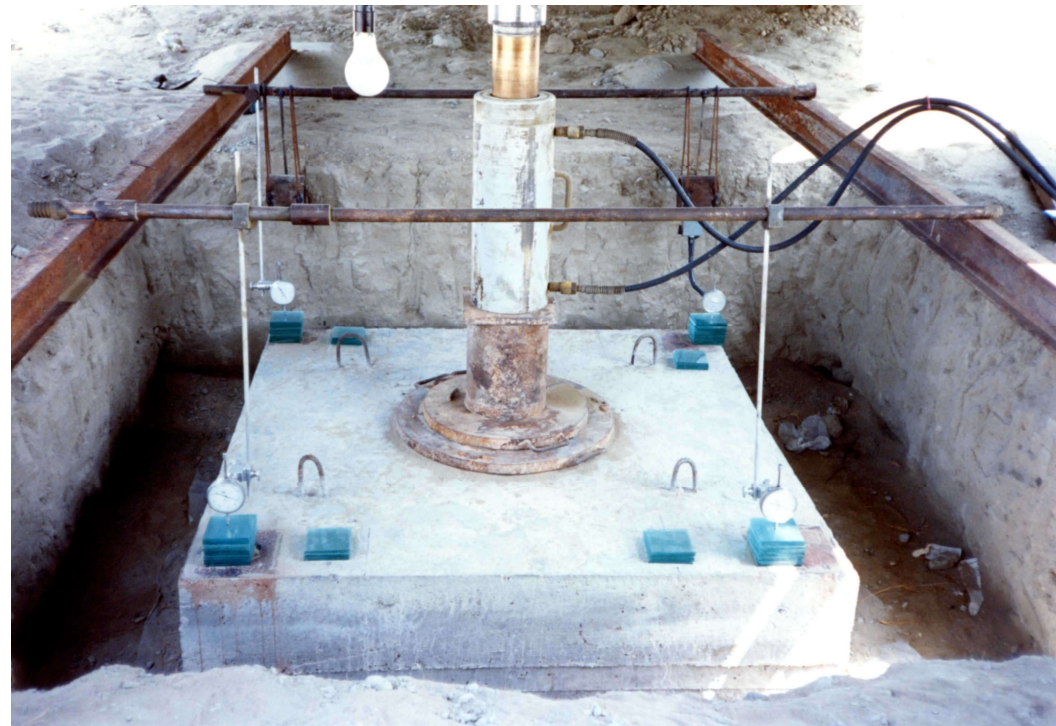


IRAN SMELTER

SITE INVESTIGATION – LOADING TESTS (1)



SITE INVESTIGATION – LOADING TESTS (2)



IRAN SMELTER

PILE LOAD TEST

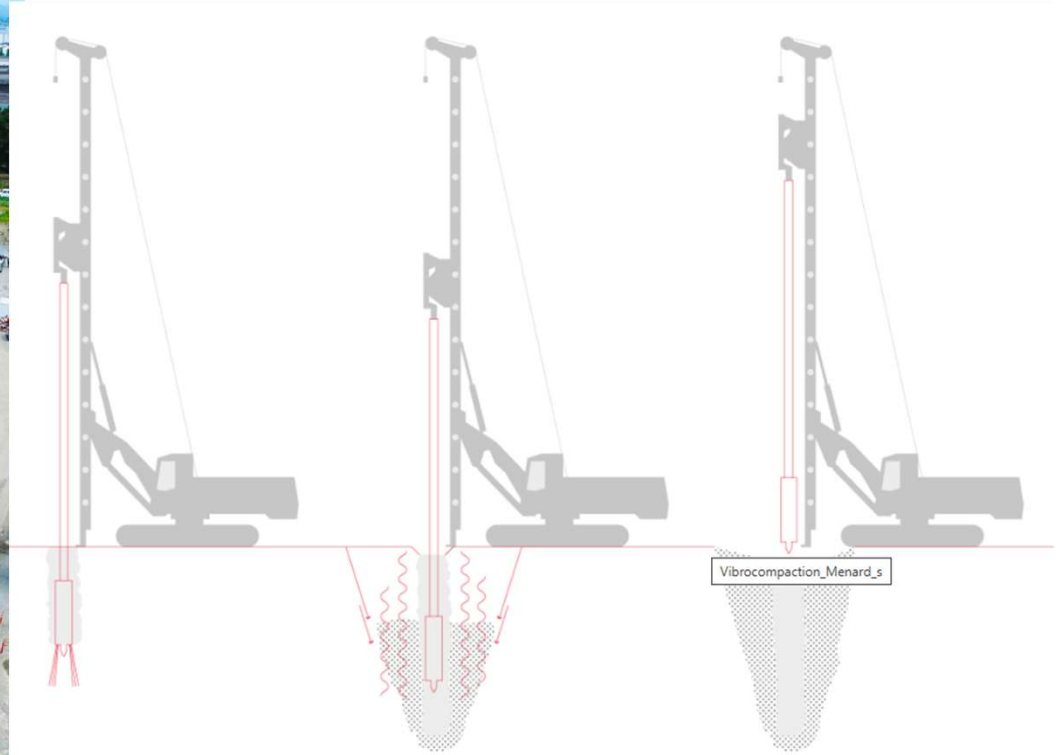


HAYES BYPASS

GROUND IMPROVEMENT

- **LOOSE OR VOIDED SOILS**
- **VIBRO COMPACTION**
 - By inserting a vibrating poker into the ground
- **DYNAMIC COMPACTION**
 - Dropping heavy weights
 - Using a heavy roller
- **GROUTING**
 - Injecting a sand/cement/bentonite mixture under pressure
 - Chemical grout

VIBRO COMPACTION



Images courtesy of Menard

DYNAMIC COMPACTION (1)



ALUMINIUM SMELTER SITE
BANDAR ABBAS, IRAN

DYNAMIC COMPACTION (2)



GOSPORT



CAMBRIDGE

BOTH SITES WERE FORMER LANDFILLS

FOUNDATIONS IN BEACONSFIELD (1)

- HOUSE FOUNDATIONS
 - SHALLOW FOUNDATIONS
 - Until late 1900s houses founded at depths less than 1m
 - Increase frequency of Subsidence, Settlement, Cracking
 - Investigations and Research – Chalk Solution Features
 - ALTERNATIVE FOUNDATIONS
 - Post 2000
 - Better Site Investigations
 - CFA Piled Foundations or on Vibro Compacted Ground

FOUNDATIONS IN BEACONSFIELD (2)

- SOLUTION FEATURES (Sink Holes or Swallow Holes)
 - CHALK – Covered with layers of Clay, Sands and Gravels. Present at depths generally 1-10m
 - SURFACE WATER (rainfall) penetrates down to chalk over a geological timescale
 - SOLUTION of CHALK at Soil/Chalk interface
 - OR enters JOINTS or FRACTURES and forms VOIDS deep in the chalk
 - INFILLED with overlying soils
 - VOID migrates up towards ground surface
 - INFILL in METASTABLE condition
 - SOAKAWAYS – Road and Roof drainage
 - LEAKING WATER MAINS AND SEWERS – Under Roads
- HOUSE IN CURZON AVENUE

FOUNDATIONS IN BEACONSFIELD (3)

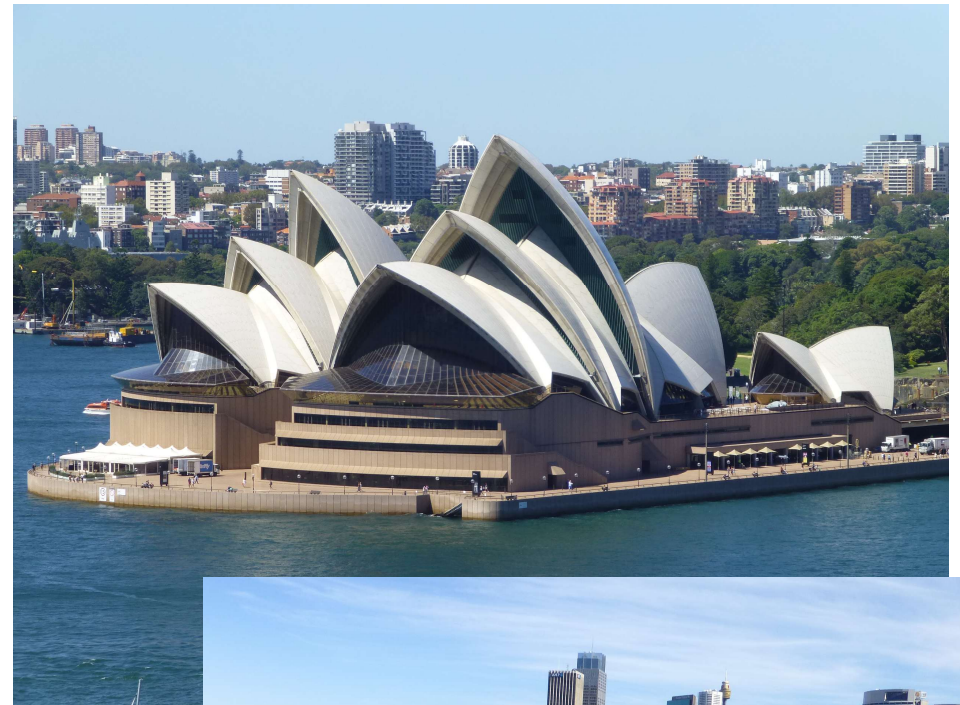
• TREES AND CLAY SOILS

- MOISTURE CONTENT CHANGES – Summer and Winter
 - Open space areas
 - Close to Trees
- SHRINKAGE OF THE CLAY followed by REHYDRATION/SWELLING
 - Sandy clays or Heavy clays (London Clay)
- 1976 and GUIDANCE BY NHBC
 - Shrinkability of Clay
 - Type of Tree
 - Mature Height of Tree
- FOUNDATIONS placed at greater depths below
- ZONE OF INFLUENCE OF TREES

SYDNEY OPERA HOUSE



1971



2015

