ELISA:
FROM NUMERICAL MODELLING TO OFFSHORE INSTALLATION

Joaquín Urbano. Msc. Naval Architect & Marine Engineer
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• ESTEYCO WHO WE ARE
• ELISA FUNDAMENTALS
• NUMERICAL MODELLING
• OFFSHORE INSTALLATION
WHO WE ARE

8 years of offshore wind technologies development

+1000 WIND FOUNDATIONS PER YEAR

+400 BRACED FOUNDATION FOR ONSHORE WWFF

+1600 CONCRETE WIND TOWERS

PIONEERS IN OFFSHORE WIND SUBSTRUCTURES
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CONCRETE GBS FOUNDATION:

- GRAVITY-BASED FOUNDATION → FOUNDATION THAT RESTS ON THE SEABED ONCE DEPLOYED AND IS STABLE BECAUSE OF ITS OWN WEIGHT.
- MADE OF CONCRETE → DURABILITY IN MARINE ENVIRONMENT, LOW COST WHEN COMPARED TO STEEL
- DESIGNED IN COMBINATION WITH THE ESTEYCO’S TELESCOPIC TOWER

H2020 ELISA/ELICAN PROJECTS:

Open water full scale foundation demonstrator
TELESCOPIC TOWER:

- ESTEYCO PATENTED SYSTEM
- LOW-MEDIUM HEIGHT FOR WTG ASSEMBLY
- LOWERING THE CENTRE OF GRAVITY DURING TRANSPORT AND INSTALLATION CONDITIONS → TURBINE INSTALLED AT HARBOUR
- INDEPENDENT OF HEAVY-LIFT CRANES
- COMPLETELY COMPATIBLE WITH OEM INTERNALS
ELISA FUNDAMENTALS

TIM PLATFORM:

- AUXILIARY FLOATING SYSTEM REQUIRED FOR BALLASTING OPERATION
- TIM STRUCTURE IMPROVES THE ELISA BEHAVIOUR DURING TRANSPORT
- LOW COST SYSTEM. UNMANNED, NON-PROPELLED. SMALL TUGS USED FOR TRANSPORT AND COUPLING
- DESIGNED TO BE RETROFITTED FOR MAINTENANCE OPERATIONS
BALLASTING / INSTALLATION

- INSTALLATION BY BALLASTING THE ELISA WITH 3 TUGBOATS KEEPING IT ON POSITION.
- TIM PROVIDES STABILITY ALONG THE PROCESS
- BALLASTING + TOWER LIFTING → ITERATIVE PROCESS TO KEEP THE BLADES WITH ENOUGH AIRGAP TO SEA LEVEL
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AQWA MODEL & TANK TESTING

HYDRODYNAMICS ANALYZED IN ANSYS AQWA.

THREE TANK TESTING CAMPAIGNS TO VALIDATE RESULTS AND CALIBRATE MODELS:

- PROOF OF CONCEPT IN CEDEX (2014)
- TRANSPORT TESTS IN CEHIPAR (2016)
- TRANSPORT & INSTALLATION TESTS IN IHC (2017)

* + 1 EXTRA CAMPAIGN → TIM TOWING TESTS IN CEHINAV (2018)

MAIN OUTCOMES:

- MOTIONS & ACCELERATIONS
- TIM / TOWER FORCES
HYDRODYNAMIC MODELS CALIBRATED AND VALIDATED AGAINST TANK TESTS USED TO GET FORCES IN THE STRUCTURE IN A FULL SET OF LOAD CASES, IDENTIFYING THE MAXIMUM FORCES / MOMENTS AND CONCOMITANTS.

EACH LOAD SCENARIO IS TRANSFERRED TO STAAD TO CHECK TIM & TOWER INTEGRITY → ITERATIVE PROCESS TO OPTIMIZE THE STRUCTURE.
SPECIAL CONCERN → INTERACTION TOWER – TIM GUIDING SYSTEM

A CROSS-CHECK ANALYSIS CARRIED OUT, LOOKING SPECIFICALLY AT THE GUIDING SYSTEM AND THEIR CONTACT WITH THE TOWER.

RESULTS SIMILAR TO THOSE FROM AQWA-STAAD.
WIND TURBINE TO BE CHECKED IN TRANSPORT / INSTALLATION CONDITIONS

ALTRAN, ON BEHALF OF GAMESA, CARRIED OUT A 3RD PARTY ASSESSMENT USING BLADED FOR THE TRANSPORT CONDITION TO EVALUATE THE TURBINE INTEGRITY, MAINLY IN TERMS OF TILT ANGLE AND ACCELERATIONS.

BLADED MODEL UNDERDAMPED → CONSERVATIVE APPROACH

RESULTS ALWAYS WITHIN SECURE RANGES FOR THE TURBINE COMPONENTS INTEGRITY AS PER GAMESA THRESHOLDS
OWN ANALYSIS WERE CROSS-CHECKED WITH TWO DIFFERENT 3RD PARTY REVIEWS

AT DIFFERENT STAGES, RESULTS FROM AQWA MODELS WERE CROSS-CHECK AGAINST SESAM RESULTS.


RESULTS ALWAYS IN THE SAME ORDER OF MAGNITUDE ONCE MODELS WERE PROPERLY CALIBRATED
MULTI-DISCIPLINARY ANALYSIS CHART

ESTEYCO. NAVAL ARCHITECTURE TEAM

ESTEYCO. STRUCTURAL TEAM

ESTEYCO. MECHANICS TEAM

IHC, CEHIPAR, CEHINAV, CEDEX: TANK TESTING FACILITIES

DNVGL, COREMARINE, ALTRAN: 3RD PARTY ASSESSMENT

HANDS-ON CALCULATIONS + PRELIMINARY STRUCTURAL & HYDRODYNAMIC MODELS

PROOF OF CONCEPT TANK TESTING CAMPAIGN

TRANSPORT CONCEPT TANK TESTING CAMPAIGN

BLADED ANALYSIS. WTG LIMITS CHECK

AQWA HYDRODYNAMIC CONCEPT ANALYSIS

STAAD STRUCTURAL CONCEPT ANALYSIS

TRANSPORT & INSTALLATION DETAILED TANK TESTING

CROSS CHECK: SESAM

AQWA HYDRODYNAMIC DETAILED ANALYSIS

STAAD STRUCTURAL DETAILED ANALYSIS

GUIDING SYSTEM DETAILED CHECK: NEMOH+ABAQUS

CROSS CHECK: SESAM

AQWA HYDRODYNAMIC FINAL ANALYSIS

STAAD STRUCTURAL FINAL CHECK
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ELISA SET SAIL THE 20TH OF JUNE 2018 AT 18.00 APPROXIMATELY.
- THERE WAS A TRIP OF AROUND 12-14 HOURS BEING TOWED.
- BALLASTING OPERATION STARTED AT 8.00 THE 21ST OF JUNE 2018.

ELISA WAS FULLY MONITORED WITH PLENTY OF SENSORS INSTALLED ALL ALONG THE PLATFORM. SPECIALLY ACCELEROMETERS AND CLINOMETERS WERE CONTROLLED FROM A SEAKEEPING POINT OF VIEW.
NUMERICAL / TANK OUTPUTS vs ACTUAL FIGURES

MAX. HEELING ANGLE [degrees]

<table>
<thead>
<tr>
<th></th>
<th>AQWA</th>
<th>TANK TESTS</th>
<th>3RD PARTY REVIEW</th>
<th>REAL FIGURES</th>
<th>GAMESA LIMITS</th>
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<tr>
<td>TRANSPORT</td>
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<td>BALLASTING</td>
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MAX. WTG HORIZONTAL ACCELERATION [m/s²]

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</thead>
<tbody>
<tr>
<td>TRANSPORT</td>
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<td>BALLASTING</td>
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ELISA TECHNOLOGY BY ESTEYCO

SELF BOUYANT GBS FOUNDATION AND TELESCOPIC TOWER FOR CRANELESS INSTALLATION OF COMPLETE OFFSHORE WIND TURBINES
CONSTRUCTION OF THE 5MW DEEP WATER PROTOTYPE (CANARY ISLANDS)

PROJECT PARTNERS:

Thank you

Joaquin Urbano, MSc Naval Architect joaquin.urbano@esteyco.com
Javier Nieto, MSc Civil Engineer Head of Offshore Department javier.nieto@esteyco.com
Jose Serna, MSc Civil Engineer, ESTEYCO CTO and Board Member: jserna@esteyco.com