RISK ANALYSIS APPLIED TO SCOUR DYNAMICAL PROTECTION SYSTEMS FOR OFFSHORE FOUNDATIONS OPTIMISATION

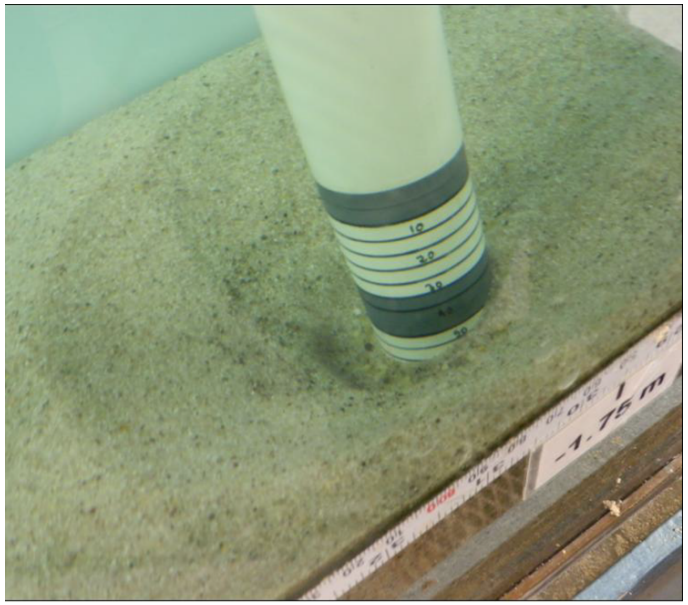
Review of the work performed, preliminary results and future research.

Tiago Fazeres Ferradosa

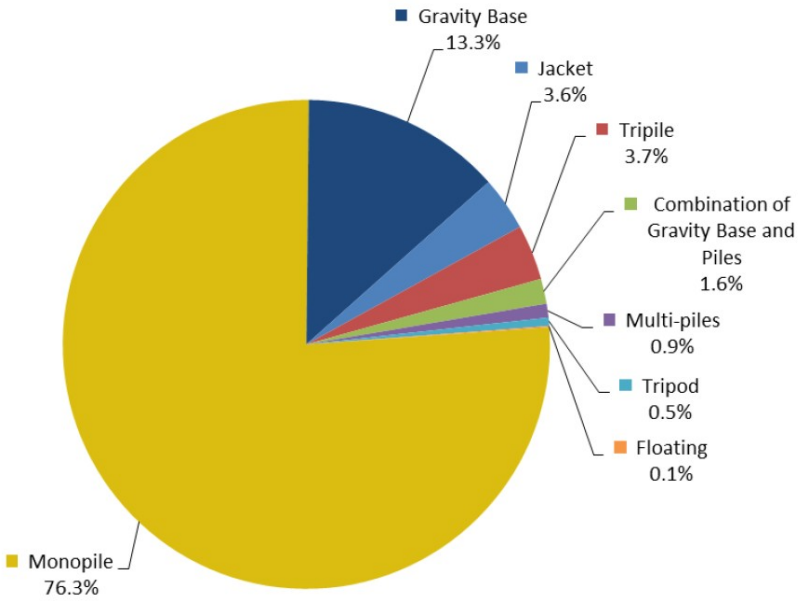
Summary

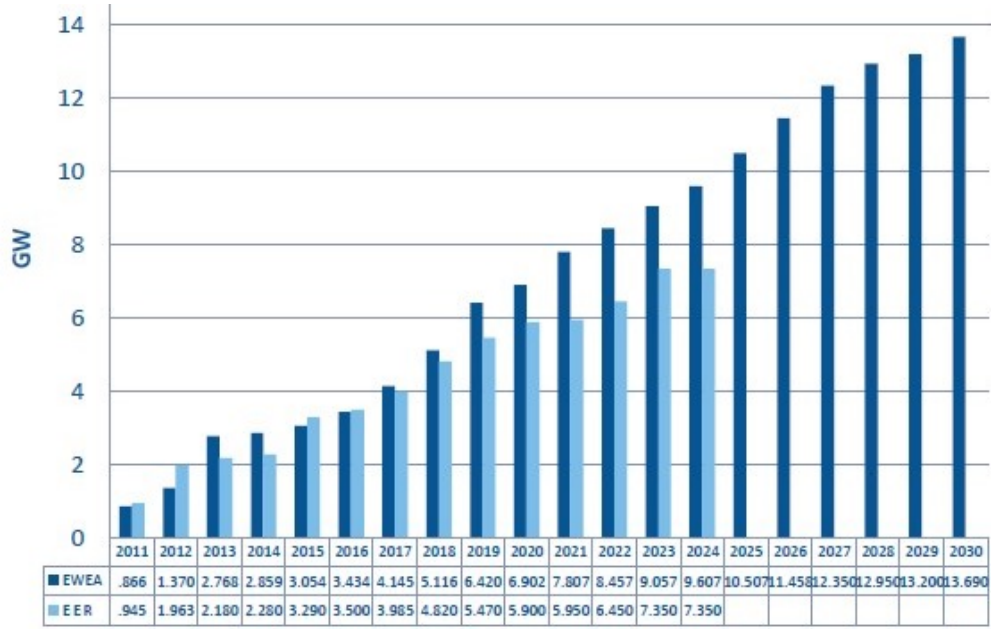
- Introduction;
- Literature Review and Basic Concepts;
- Risk and Reliability methods *vs.* Empiric scour design;
- Pre-assessment of dynamic scour protection systems;
- Reliability based approach to offshore scour phenomena;
- Conclusions and Future Work;

Introduction



- Growing market with growing tendencies;
- Monopiles are the most common substructure;
- Scour can occur in several types of structures;
- Scour may lead to expensive solutions that require optimization;

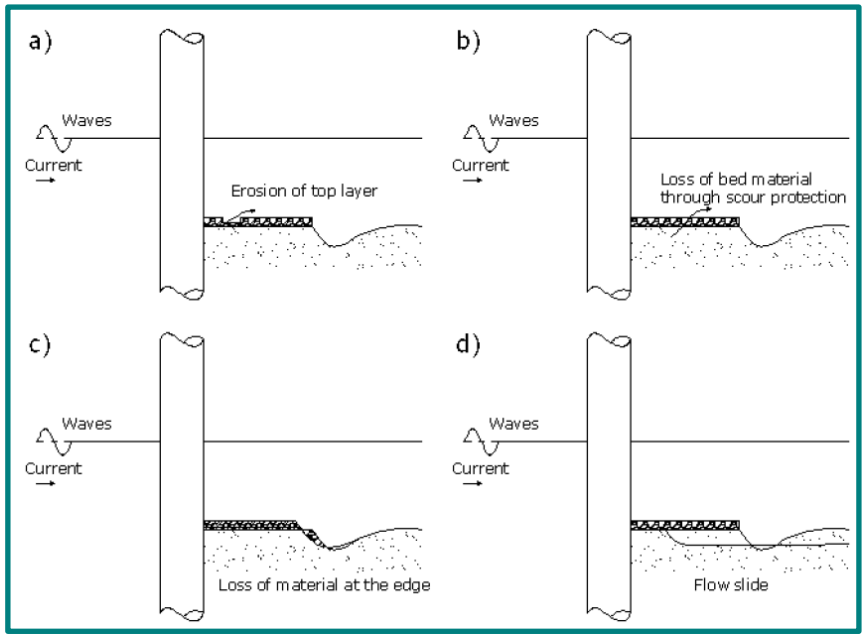


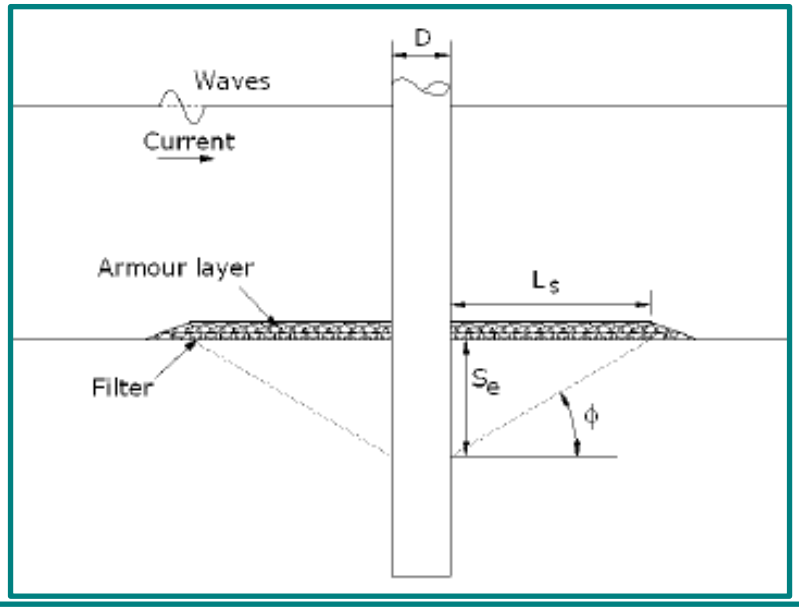


	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
EWEA	.866	1.370	2.768	2.859	3.054	3.434	4.145	5.116	6.420	6.902	7.807	8.457	9.057	9.607	10.507	11.458	12.350	12.950	13.200	13.690
EER	.945	1.963	2.180	2.280	3.290	3.500	3.985	4.820	5.470	5.900	5.950	6.450	7.350	7.350						

Literature review and Basic concepts

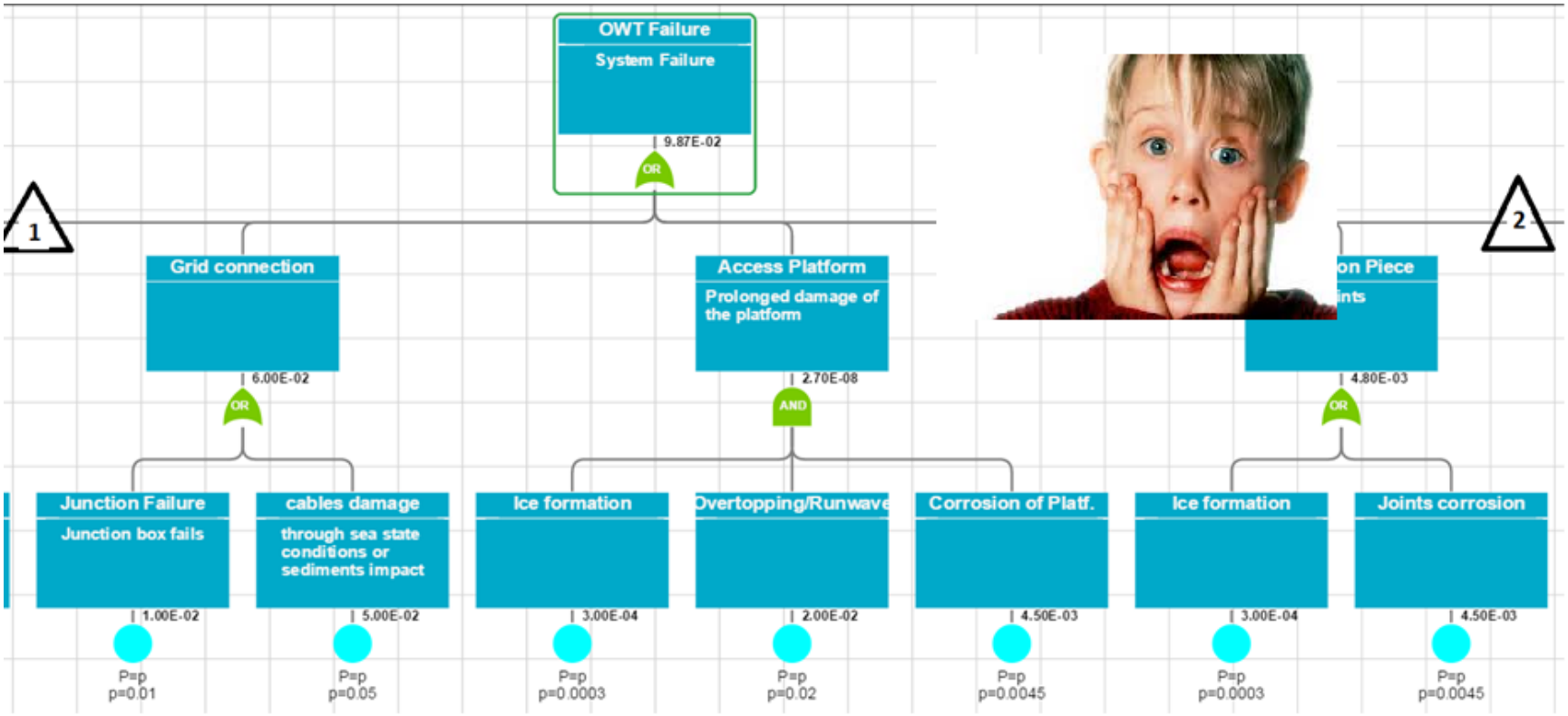
- Several configurations have been suggested for the protection, all of them with semi-empiric nature;
- Several failure mechanisms imply several limit state functions;
- Uncertainty surrounds this problem both in loads and resistances;
- Uncertainty can only be treated statistically;
- Instead of semi-empiric theories a measure of reliability is needed for design purposes – Reliability Index and Probability of failure.





Optimisation, Inovation, Description and Quantification of concepts

In the beginning it seemed impossible to deal with such amount of uncertainty and to reach a suitable concept of optimisation.

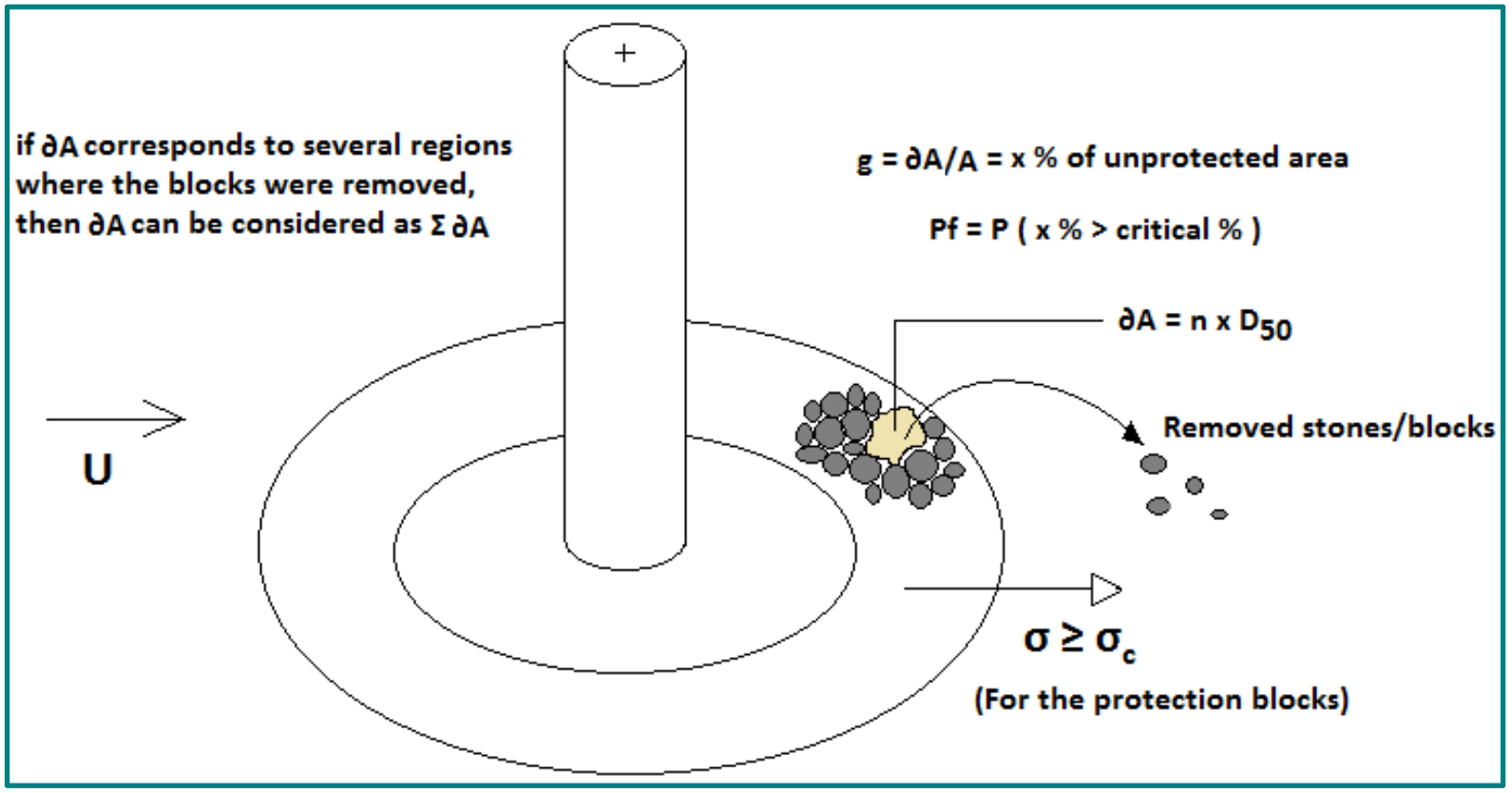


The new concept

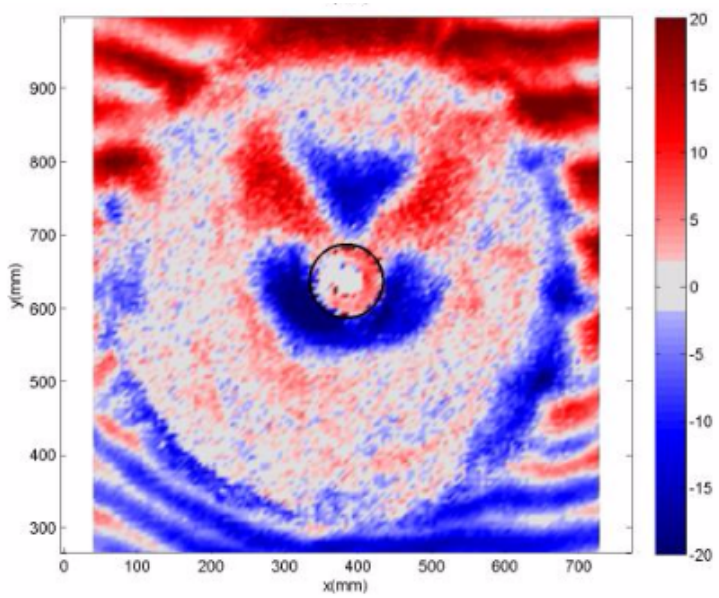
A truthful evaluation can only be made through risk analysis and risk quantification. The concept must have a measure of risk and reliability by:

-knowing the probabilities.

-knowing the consequences.



Pre-assessing the dynamic scour protection



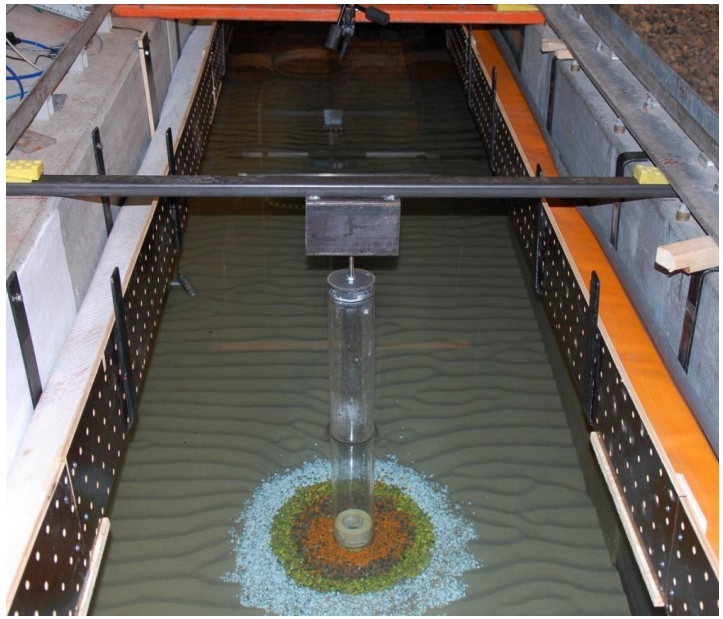


Table 1 – Preliminary results of sucessfull configurations for the protection system.

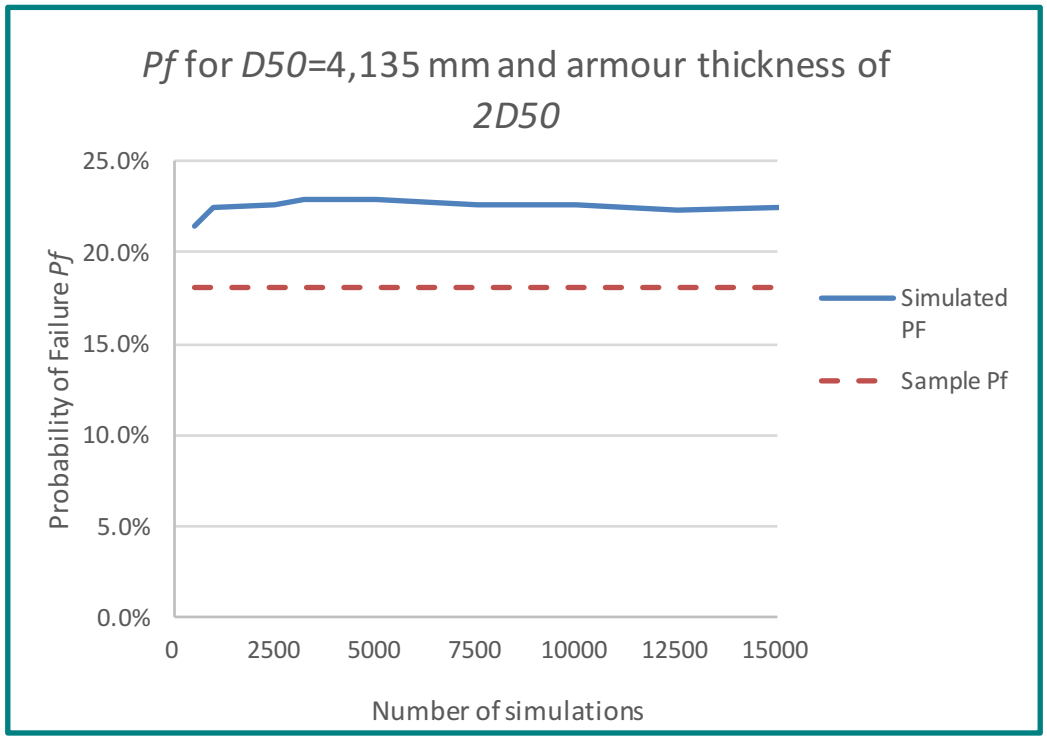
Classification of test results: failure (red), statically stable (blue) and dynamically stable (green)

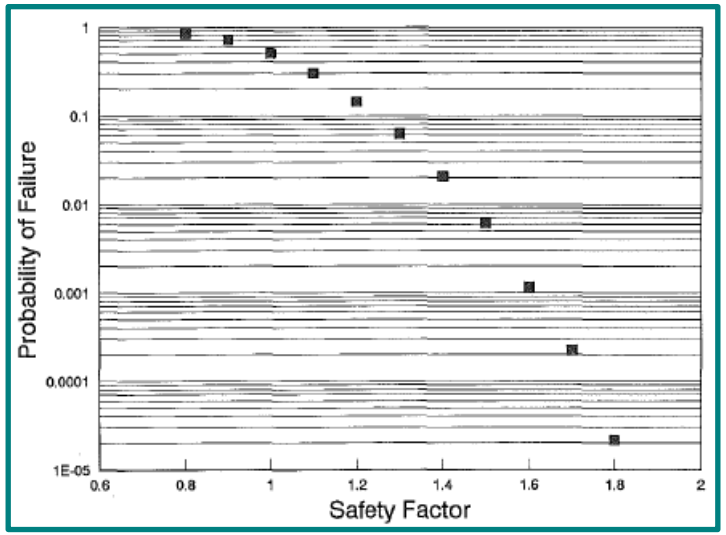
Test series	Armour 1	Armour 2	Armour 3	Armour 4
s1	**$4D_{50}$ (s1_001)**	**$2D_{50}$ (s1_002)**	**$2D_{50}$ (s1_004)** **$3D_{50}$ (s1_003 and 6)**	**$8D_{50}$ (s1_005)**
s2	**$2D_{50}$ (s2_001)**	**$2D_{50}$ (s2_002)**	**$3D_{50}$ (s2_003)** **$4D_{50}$ (s2_004 and 6)**	**$8D_{50}$ (s2_005)**
s3		**$2D_{50}$ (s3_001)**	**$2D_{50}$ (s3_002 and 10)** **$3D_{50}$ (s3_004, 8 and 9)** **$4D_{50}$ (s3_003)**	**$4D_{50}$ (s3_006)** **$6D_{50}$ (s3_007)** **$8D_{50}$ (s3_005 and 11)**

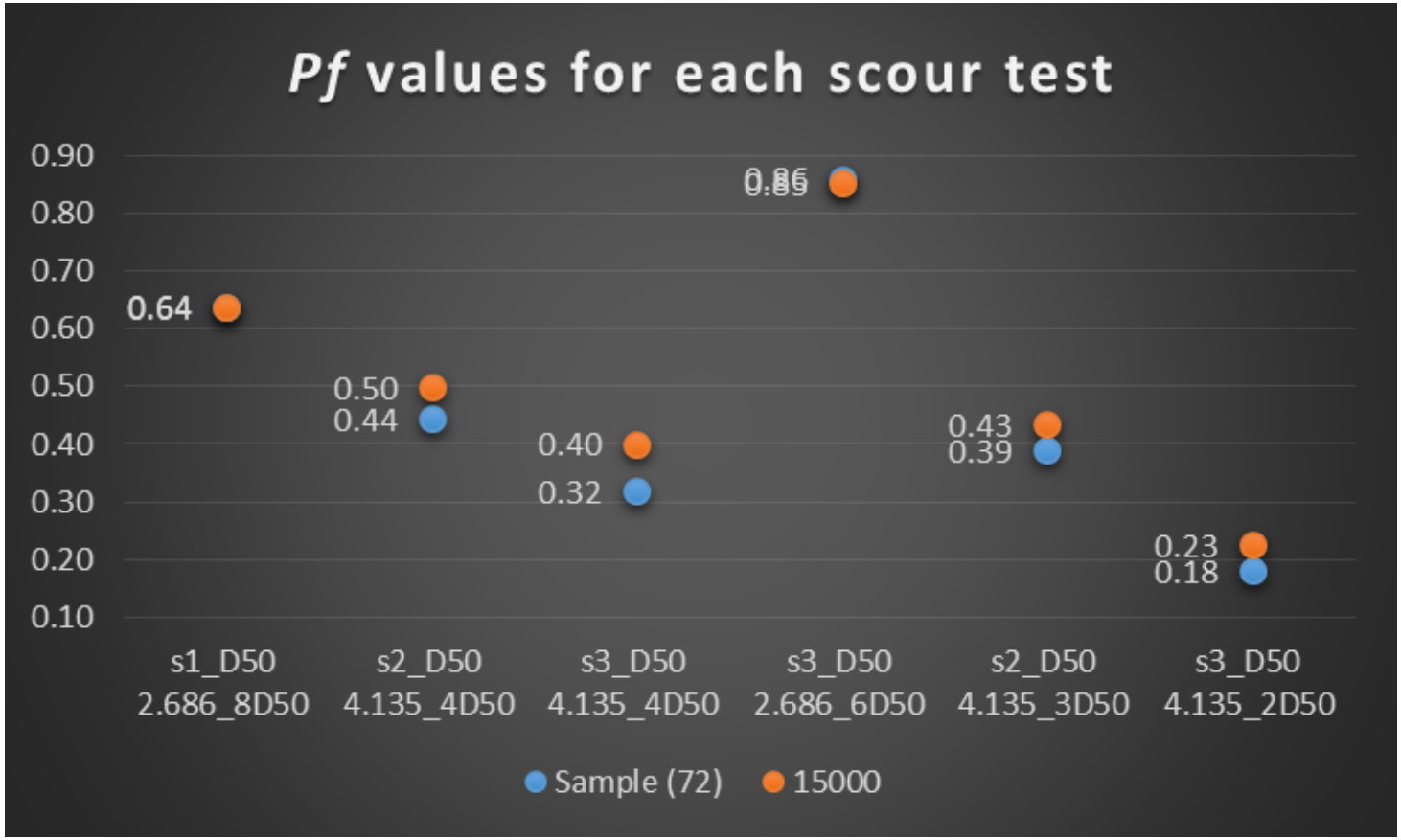
Reliability methods applied to scour – Pre-assessment of a performance function

Table 2 – Preliminary results of Pf for a design performance fuction with Gumbel's fitting

Nº of Simulations	Simulated PF
Sample	0,181
500	0,214
1000	0,224
2500	0,226
3250	0,229
5000	0,229
7500	0,226
8750	0,226
10000	0,226
12500	0,224
15000	0,225







- Pf decreases of the top layer increases, for the same D50;
- Lower water depths lead to higher values of Pf for the same armour thickness and D50;
- Decreasing the values of D50 don't necessarily lead to higher Pf since if the armour thickness increases Pf may decrease;
- Further data gathering and analysis is required for a more generalised analysis.

Conclusions

- At the present moment the following general conclusions were dawned:
  - The feasibility of dynamic scour protections is possible leading to an optimisation of the investments made in the foundations of offshore structures.
  - The physical modelling proved the concept but is still in need for more data and larger scale tests.
  - The comparisons with literature review also provided interesting perspectives on future developments.
  - Reliability methods are applicable to scour protections design, provided that a suitable performance function is achieved;
  - The pre-assessment of a design performance function was successfully done;

  The next year will provide a base for the risk analysis to be performed in scour protection systems of offshore foundations. If successfully implemented, the new methodology gives the base for the application of Level 4 structural design codes in offshore foundations design, with a risk assessment included.

Future work – the upcoming year of 2015/2016

- Dynamically stable scour protections:
  - Physical modeling – scour tests – continuation of 2015;
  - Data sampling and statistical characterization of the random basic variables – avoid fitting and seek for simulation models;
  - Performance function evaluation (limit state function);
  - Complex loads combinations, particularly with waves and currents combined.
- Risk and Reliability methods for scour protections:
  - Statistical model development;
  - Evaluation of the reliability techniques applicable for the design performance function;
  - Development of guidelines for the new design methodology;
  - Validation with a case study.

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STILL STRONGLY COMMITED TO INITIAL SCIENTIFIC DREAM!

Bring on the year of 2015/2016!

THANK YOU!