DATA IN BRIEF

**Meta-Data**

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| **\*Title:** | Dataset on Composite Riser Model for Deep Water Application |
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| **\*CATEGORY:** | *Mechanics of Materials* |

**Data Article**

**Title**:Dataset on Composite Risers for Deep Water Application

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**Abstract**

The local design of composite riser for deep water application has been carried out using ANSYS ACP for six design load cases and the model validated. Different materials used in the design of the composite riser, stacking sequence, orientation angles and the liner materials. Application of netting theory and optimization carried out with different categories were presented both in the research paper and in the dataset from the MATLAB code. For further interpretation of the data presented in this article, please see the research article ‘Composite Risers for Deep Waters Using a Numerical Modelling Approach - Amaechi Chiemela Victor, Gillett Nathaniel, Odijie Agbomerie Charles, Hou Xiaonan, Ye Jianqiao; *Composite Structures,* 2018’ [1].

**Specifications Table**

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| --- | --- |
| Subject area | *Physics, Chemistry, Engineering* |
| More specific subject area | *Composite Structures; Materials Engineering* |
| Type of data | *Table, image, Matlab file, graph and figure* |
| How data was acquired | *ANSYS ACP, MATLAB* |
| Data format | *Raw, filtered and analyzed* |
| Experimental factors | *Numerical analysis was carried out on the local design of composite risers and optimization of composite riser design* |
| Experimental features | *Factor of Safety, Stress Profiles, Graphs of Design Load Cases* |
| Data source location | *Lancaster University, Engineering Department, UK* |
| Data accessibility | *Data is within this article.* |
| Related research article | *‘Amaechi Chiemela Victor, Gillett Nathaniel, Odijie Agbomerie Charles, Hou Xiaonan, Ye Jianqiao;* Composite Risers for Deep Waters Using a Numerical Modelling Approach*; Composite Structures, 2018’ [1].* [*https://doi.org/10.​1016/​j.​compstruct.​2018.​11.​057*](https://doi.org/10.​1016/​j.​compstruct.​2018.​11.​057) |

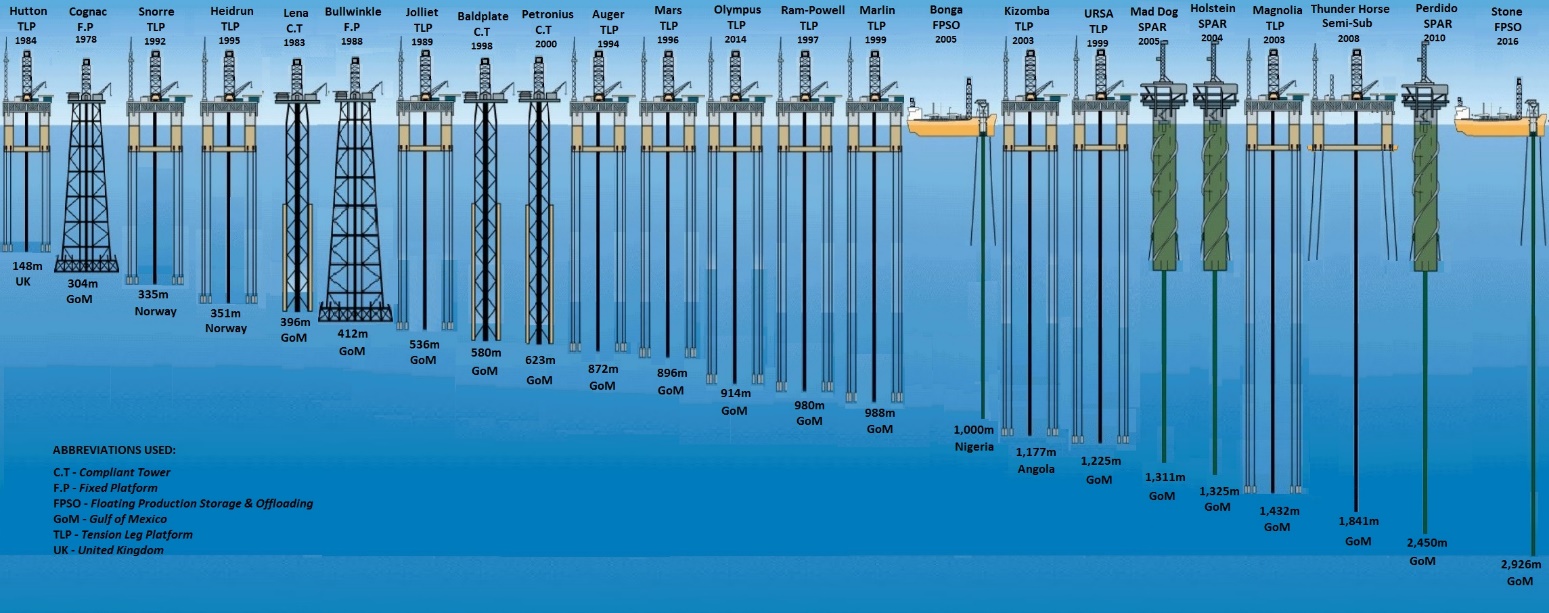
## Keywords: Composite Riser Data, Finite Element Method, Composite Riser Optimization, ANSYS ACP, Local Design of Composite Riser, Stacking Sequence;

**Value of the Data**

1. This data set presents local design of composite riser using different materials. This can also be used as input properties in analytical models and validation of similar models.
2. This data can be used as input parameters in the finite element analysis of composite risers. The optimisation can be applied in the study of axial layers and hoop layers of both composite tubes and composite risers.
3. This data can be used for comparative study of other composite riser designs with full mechanical characterization of the composite riser for deep water application.
4. The data can be applied in production of composite riser prototypes, and other experiments. It can also be used for investigating on global analysis of composite risers.
5. The data can be used as benchmark for standards development on Composite Risers, considering the factor of safety and stress investigations for different stress components of the composite risers.

**1. Data**

The datasets are for the local design of the composite risers, as supplements to those presented in [1]. The MATLAB file is used in the plot of the finite element analysis from ANSYS ACP (Pre) and ANSYS ACP (Post). Optimization considerations are also investigated based on different parameters. An example is the layer orientation, as presented in Figures 4 and 5 and in Section 3.5 of the research article [1].



**Figure 1 Historical development of some offshore platforms in deep waters at different water depths [3]**

**2. Design, Materials, and Methods**

**2.1 The Design**

Some designs of composite structures like submarine hoses [2] and composite risers [3] have been carried out for deep water applications. However, the design considered in this paper is for a 2,000m deep water riser using the parameters presented in Table 1. Figure 1 illustrates different deep water structures with increasing water depth, thus an increase in riser length. Thus the need for lighter weight risers. Composite risers are proffered as potential solutions to this problem [3]. In this composite riser design, three approaches are considered: the analytical design, conventional design and the numerical design. The analytical design is used to derive the constitutive model for the composite riser. The conventional design is based on the orthogonal design of composites, where laminate reinforcements are arranged in only axial and hoop directions. In this method, the plies are in the orientations of 0o and 90o. The reinforcements of the composite riser are designed in axial, angled and hoop directions. The mechanical properties of the composite materials considered are presented in Table 2. Different liner materials are also applied, as given in Tables 3. In addition, the stack-up sequence for the plies and the fibre orientations for the body of the composite riser are considered in the design, as given in Table 4. The design process starts with the design of the composite riser geometry in Design Modeler in ANSYS 19.0. Next, a Mechanical Model is developed in ANSYS Workbench. The Engineering Data are then developed and the model set up. It is then connected to the Static Structural model. Another setup using the same geometry with different liner thickness is developed. Next, an ACP (Pre) model is set-up and the material properties are developed. Then, the ACP (Post) model is also developed for the post-processing. The ACP (Pre) is then connected both the Static Structural model and the ACP (Post) model. Different design cases for the 6 loading conditions are considered. This process is carried out to get the best model for the design. The axial, off-axis and hoop reinforcements are all considered in the design procedure as presented. The initial design variables are first inputted. Next, the FEA is carried out using these values. The off-axis (angled) plies was determined as +53.5° using Netting Theory. However, the design was optimized as presented in Section 3.5 in [1]. A maximum stress criterion is used to determine the layers/lamina that fail due to stresses exceeding the lamina strengths. This is used in calculating the Factor of Safety (F.S) for each of the layers, as presented in [1].

**2.2 Material Properties**

The parameters of the geometry were determined in the design stage as given in Table 1. Other important details include the thickness of the laminate layers, the stacking sequence, the liner thickness and the orientations of the fibre. High-performance materials are considered for both the fibre and matrix combinations. The properties for the Poisson’s ratios (ʋ**1**, ʋ**2** and ʋ**3**), the elastic moduli (E1, E2 and E3) and the shear moduli (G12, G13 and G23) are presented in Table 2. The subscripts 1 and 2 represent fibre and transverse directions, respectively. Subscript 12 represent the in-plane shear direction. Figure 2 represents the coordinate systems of the composite riser, showing different orientations as considered in the design in ANSYS ACP. The composite riser has in-plane effective properties and other material properties. Details of the material properties used in this investigation are presented in Tables 2 and 3.

|  |  |
| --- | --- |
| (a) | (b) |
| (c) | (d) |
| **Figure 2 Composite riser section showing the orientations of fibre reinforcements in ANSYS ACP (Pre) version 19.0 at: (a) 0o , (b) 90o , (c)+53.5o and (d) -53.5o** | |

**Table 1 Composite Riser Parameters [1]**

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Length of Riser (m) | 3 |
| Outer Diameter (m) | 0.3048 |
| Surface Area (m2) | 7.6605 |
| Number of Layers | 18 |
| Water Depth (m) | 2000 |

**Table 2 Mechanical Properties of the unidirectional fibre-reinforced plastic composite [1]**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Material** | **Density (kg/m3)** | **E1 (GPa)** | **E2=E3 (GPa)** | **G12=G13 (GPa)** | **G23 (GPa)** | **(GPa)** | **(GPa)** | **(GPa)** | **(GPa)** | **τ12 (GPa)** | **ʋ12= ʋ 13** | **ʋ 23** |
| AS4/PEEK (APC2) | 1561 | 131 | 8.7 | 5.0 | 2.78 | 1648 | 864 | 62.4 | 156.8 | 125.6 | 0.28 | 0.48 |
| IM7/PEEK (APC2) | 1320 | 172 | 8.3 | 5.5 | 2.8 | 2900 | 1300 | 48.3 | 152 | 68 | 0.27 | 0.48 |
| P75/PEEK (APC2) | 1773 | 280 | 6.7 | 3.43 | 1.87 | 668 | 364 | 24.8 | 136 | 68 | 0.30 | 0.69 |
| AS4/Epoxy (938) | 1530 | 135.4 | 9.37 | 4.96 | 3.2 | 1732 | 1256 | 49.4 | 167.2 | 71.2 | 0.32 | 0.46 |
| P75/Epoxy (938) | 1776 | 310 | 6.6 | 4.1 | 2.12 | 720 | 328 | 22.4 | 55.2 | 176 | 0.29 | 0.70 |
| Glass fibre/ Epoxy (S-2) | 2464 | 87.93 | 16.0 | 9.0 | 2.81 | 4890 | 1586 | 55.0 | 148 | 70 | 0.26 | 0.28 |
| Carbon fibre/ Epoxy (T700) | 1580 | 230 | 20.9 | 27.6 | 2.7 | 4900 | 1470 | 69 | 146 | 98 | 0.2 | 0.27 |
| **PEEK- Poly ether ether ketone; T700– Toray carbon fibre; S-2 – AGY glass fibre;**  **subscript 1- fibre direction; subscript 2- transverse direction; subscript 3- in-plane shear direction;**  **superscript T- tension; superscript C- compression.** | | | | | | | | | | | | |

**Table 3 Mechanical Properties of the liner material [1]**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Material** | **Density (kg/m3)** | **Elastic Modulus(MPa)** | **Yield Stress(MPa)** | **Ultimate Stress (MPa)** | **Elongation at break(%)** | **Poisson’s ratio, ʋ** |
| Aluminium (1953T1) | 2780 | 71 | 480 | 540 | 7.5 | 0.3 |
| PA12 | 1010 | 540 | 1500 | 54 | 10 | 0.4 |
| PEEK (Victrex) | 1300 | 4.0 | 110 | 125 | 45 | 0.4 |
| PVDF | 1780 | 550 | 1540 | 54 | 10 | 0.4 |
| Titanium (Ti6Al4V) | 4430 | 113.8 | 880 | 950 | 14 | 0.342 |
| Steel (X80) | 7850 | 207 | 880 | 950 | 5.9 | 0.3 |
| **PA12– Polyamide 12; PEEK- Poly ether ether ketone; PVDF– Polyvinylidene fluoride;** | | | | | | |

**Table 4 Stack-up Sequence and Orientation of Composite Plies [1]**

|  |  |  |  |
| --- | --- | --- | --- |
| **Layer** | **Thickness (mm)** | **Orientation (°)** | **Description** |
| 0 | 2.0 | 0 | Liner |
| 1 | 1.58 | 0 | Hoop Layers |
| 2 | 1.58 | 0 |
| 3 | 1.58 | 0 |
| 4 | 1.58 | 0 |
| 5 | 1.88 | 53.5 | Off-axis Layers |
| 6 | 1.88 | -53.5 |
| 7 | 1.88 | 53.5 |
| 8 | 1.88 | -53.5 |
| 9 | 1.88 | 53.5 |
| 10 | 1.88 | -53.5 |
| 11 | 1.88 | 53.5 |
| 12 | 1.88 | -53.5 |
| 13 | 1.88 | 53.5 |
| 14 | 1.88 | -53.5 |
| 15 | 1.62 | 90 | Axial Layers |
| 16 | 1.62 | 90 |
| 17 | 1.62 | 90 |
| 18 | 1.62 | 90 |

|  |
| --- |
| 1. Composite Riser length in ANSYS ACP (Pre)   (b) Stack-up of the layers  Hoop layers (14-18)  Axial layers (1-4)  Off-axis layers (5-14)  1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  16  17  18 |

**Figure 3 Finite element model of composite riser showing parametric stack-up of layers**

**2.3 Methodology**

The numerical method used in this design is the Finite Element Method (FEM). The 3m composite riser model is developed in ANSYS ACP. The parameters for the composite riser is given in Table 1. Details of the boundary conditions and design methodology are presented in [1]. In the FEA, a quadrilateral mesh type is applied. The FEA model is designed with 30 axial divisions and 80 circumferential divisions, involving 16,950 nodes and 2,400 elements [1]. The composite riser is analysed as a shell body in ANSYS ACP 19.0. Multiple material layup configurations are designed with 18 layers considered in each CPR design, as presented in Table 4. In this design, the axis for the layers for the material as designed from outer layer to inner layer, is shown in Figure 3 (a). The finite element model showing the stack-up for the materials for the composite riser with [04,(±53.5)5,904] configuration in ANSYS ACP (Pre) is as illustrated in Figure 3 (b).

**2.4 Optimization**

Optimization plots are available in the Matlab file used in the plots. Presented here are the optimization consideration for layer orientations. Other optimization considerations are presented in [1], for the optimization. The study presented the stress distribution for the effect of axial layer orientation and hoop layer orientation respectively, carried out for burst case. Different orientations were investigated, such as [(0)4,(±53.5)5,(90)4], [(0)4,(±53.5)5,(89)4] and [(0)4,(±53.5)5,(88)4].

**Conflict of Interest**

The authors of this article declare that they have no conflict of interests.

**Acknowledgments**

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