General comments:

The paper performs OpenFAST simulations of the 15-MW FOWT with a conventional mooring configuration under 1,000 sea states, and applies five surrogate models to evaluate their predictions of hourly mooring fatigue damage. The best surrogate model, which has the lowest R^2 values, is further used to estimate the uncertainty.

The paper is well-structured, and the topic of mooring fatigue monitoring is interesting, particularly with the use of surrogate models, which greatly improve efficiency. However, the novelty of the paper is not sufficiently demonstrated through the methods and results. The following comments are provided, with the hope of improving the quality of the paper.

1. Introduction part:
    a. In line 39, the paper mentions a target of 60 GW by 2030. Please verify this with the latest literature, such as the Global Wind Report 2024 by the Global Wind Energy Council, which sets a target of 320 GW by 2030.

    b. The introduction does not clearly demonstrate the novelty of the proposed surrogate model in this study. What new functions or methods does the proposed surrogate model introduce? Or is it merely incorporating two more environmental variables—wave period and wind-wave misalignment—into tension prediction for digital-twin technology? How importance of these two factors in mooring fatigue?
    In lines 45–60, the paper discusses the high risk of mooring failures in the offshore oil and gas (O&G) sector, and the mitigation of these risks using tension sensors for real-time measurement. Furthermore, the literature cited in lines 60–65 mentions a platform motion-based method that addresses the issues associated with tension sensors.
    However, the paper does not further elaborate on the novelty of the proposed approach. For instance, what is the specific importance of the surrogate model for condition monitoring? Why not use a GPS sensor directly instead of relying on a surrogate model? Since there is no interactive feedback for the operational or maintenance adjustments, but only post-processing of measurement data for fatigue prediction, how does the surrogate model or even digital twin technology offer a distinct advantage?

    c. The introduction lacks sufficient evidence to support the surrogate model's ability or digital twin technology to improve long-term mooring integrity in terms of fatigue. Fontaine et al. (2014), as the paper cited in line 55, found that 3 out of 29 mooring fatigue failures were caused by out-of-plane bending of chain links. In this case, in addition to tension values, the angles between two links are also crucial.

    However, the paper does not further discuss the capability of the platform motion-based surrogate model to predict the angles between two links. How did the surrogate models in literature (specially the platform motion-based method cited in line 60-65) or the proposed method for digital-twin technology, which in this paper incorporates two additional environmental variables, address this issue?

2. In the ‘Reference system’ section: please clarify the mooring pretension used in this study. Since varying pretensions influence the mooring stiffness and tension damage.

3. In the ‘Generation of the synthetic database’ section:
    a. the paper describes OpenFAST as a ‘high-fidelity’ tool; however, its official webpage (https://openfast.readthedocs.io/en/main/) refers to it as a ‘multi-fidelity’ tool. Typically, CFD simulations are classified as ‘high-fidelity’.
    b. In line 116, the paper states that the sampling technique aims to avoid conditions that would never occur. Please clarify this sampling method further, especially in the context of using the ‘non-site-specific training’ approach for input variables.

    c. Figure 1 should be modified by using more distinct blocks, as the current shapes are not obviously different, and please mark the blocks that are not involved in this paper in the figure.

    d. In line 127, the paper states that ‘the selected samples are physically meaningful’, please further clarify this. Typically, wind drives the ocean waves, so does the sampling account for the wind-wave empirical correlation function? Or does it consider the wave-steepness characteristics?

    e. As mooring configuration is particularly site-specific, for instance, the water depth determines the total length, while the soil conditions decides the anchor selection. However, the sea state sampling is based on the non-site-specific training. In this sense, this paper applies a specific mooring design across 1000 sea states. How are these two principles validated simultaneously? Furthermore, how can it be ensured that the results are not mooring-specific?

    f. In case a specific environmental region is chosen, for instance North Altlantic (mentioned in line 133), what are the upper and lower bounds for all the five input environmental variables? Please provide more information on the input variable ranges.

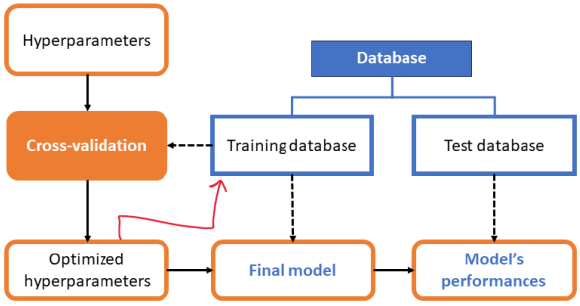
    g. In table 3, please clarify whether the simulation time length corresponds to each test case with a single specific seed or represents the total simulation length for all six seeds.

    h. Line 210 states that the S-N curve are based on tests under mean loads remain 20% of the MBL. Does this mooring configuration meet this constraint? If not, since the mean loads influence fatigue, how can the application of the S-N curve parameters be validated? Does this paper consider the influence of the mean loads in the fatigue calculation in this study? Please provide further clarification on these.

    i. From line 220-235, the effect of corrosion is considered in the fatigue damage, by using an extended S-N curve as expressed in Eq2. How does the corrosion grade parameters used in the fatigue calculation for different phases, for instance, new, 10-year usage? Does this extended S-N curve consider the specific region or specific mooring design, since all coefficients are empirical estimated? Does this violate the non-site-specific sampling principle? Please further clarify these.

j. In line 216, the paper states that corrosion is simply based on a reduction of chain diameter. This is partially correct, since for life-time fatigue prediction, marine growth is critical, as it contributes to chain corrosion. The marine growth influences not only chain diameter, but also line mass, and drag coefficient of mooring lines, how does this paper consider these influences in fatigue prediction? If marine growth is ignored, what is the justification for considering the extended S-N curve? Furthermore, corrosion also reduces chain strength over time. How is this effect incorporated into the S-N curve, considering that the minimum breaking load (MBL) also decreases with time? Please provide further clarification on these aspects.

4. In the 'surrogate model' section:
   a. in line 250-260, since the computation time is compared between OpenFAST and surrogate models, please specify the version of OpenFAST.
   b. In line 258-265, for clarity, consider replacing 'the first subsection' with 'in Section 4.1' to provide a more precise reference.
   c. In table 4, consider restructuring the contents into the categories: 'Simplicity,' 'Handling Non-Linearity,' 'Accuracy,' 'Efficiency,' and 'Best Use Case' to provide a more distinct and structured comparison.
   d. In line 300, please clarify whether the random search method is used for all five surrogate models.
   e. In Figure 3, since the optimal hyperparameters are applied to the dataset again, should the workflow be structured accordingly, like this



5. In the 'environmental condition' section:
   a. In line 379, the paper states the water depth around 100m, how does this shallower water depth align with the FOWT model, which features the hydrodynamic properties and a mooring design for sites of 200 m? In Table 2, the anchor depth corresponds to the water depth of 200 m. The hydrodynamic properties as well as the mooring pretension significantly change with shallower water. Please clarify the modifications made for the Openfast simulation.
   b. In line 384, what is the wind direction?
   c. line 387 sees two dots at sentence end.
   d. In Figure 7, consider adding the peak values and the peak frequency for each environmental variable. It appears that the wave period is discrete rather continuous, please clarify this. Furthermore, specify the spectrum used for wave modeling and the turbulence model applied for wind modeling.

6. In ‘result’ section:
    a. In line 405, the paper states the results are only for line 1 with grade 3, please justify why this line at this corrosion grade is used to represent the long-term fatigue status of three mooring lines under wind-wave misalignments.
    b. In line 415, the paper states that 800 samples were used for training the model, while the remaining 200 samples were applied for comparison purposes. Please clarify how the selection process was performed. Consider provide a distribution of fatigue damage across all sea states, to ensure that no biased sea state was excluded from the training process.
    c. Please clarify how many iterations were perform to obtain these optimal hyperparameters and which method was used for each surrogate model, since c = 10 in Support Vector Regression appears a bit high.
    d. In line 426-430, the R2 result (Figure 8 & Table 9) indicates the first three surrogate models have limitations in handling non-linearity, while these limitations are known prior to the R^2 calculation, please justify the decision to use these models with their already-known limitations.

    e. Since the comparison between surrogate models and OpenFAST simulations depends on the selection of samples, please justify why overall fitness is considered more important than capturing high-damage cases, especially when the primary motivation is to monitor mooring failure due to fatigue damage. Additionally, please clarify the occurrence of these high-damage cases and justify why their significance is being overlooked. Furthermore, since none of the five surrogate models can capture high-damage cases, does this imply that the surrogate models are not suitable for predicting critical cases?

7. In the ‘discussion’ section:
    a. In lines 500–505, the paper highlights the novelty of applying wind-wave directional misalignment. However, no evidence is provided to demonstrate the significance of this variable, especially since only one line is considered in the results. Consider adding more data to demonstrate that this variable is indeed significant in mooring fatigue. In addition, please clarify the modification of hydro properties in the OpenFAST simulation to consider this directional misalignment, when reference FOWT only has one directional hydro input.