REVIEWER 2

General comments:

It is difficult to follow the whole paper. There are some miss match between the title, abstract, method, analysis, and conclusion. The method section shows how to estimate fatigue based on a controller specification/design. However, reading other part of the paper, it shows the control designer can specify the desired fatigue reduction when designing a controller, based on which a certain control specification can be achieved. This small miss match makes it difficult to read.

We want to thank the reviewer for the very useful comments on our work. We have included most of the suggestions in our text, as they have helped improving its quality. We understand that the objectives of the work and the properties of the method have been presented in slightly different ways through the text. We have tried to eliminate the mismatches and simplify the nomenclature.

Beside this, all the loads presented are only the tower base moments (fore-aft), which are used for showing the method works nicely. But, I am missing other loads, for example, what about the loads on blade root? what about the loads for the tower bottom side-side moments and the shaft yaw and tilt moments? It would be good to mention in order to have a complete picture.

Although we consider analysing more loads out of scope for the current article, we understand the relevance and intend to cover that topic in future work.

Additionally, Dirlik's fatigue estimation method requires a method to estimate the parameters (G1, G2, and G3). However, it is not discussed how this estimation is done.

We find this suggestion might be based on a poor writing of our original text. The values of G1, G2, and G3 can be found directly by applying the formulas developed by Dirlik. We just wanted to empathise the empirical nature of the method, but we did not mean that we have performed any data fitting to it.

The paper need to be major revised before it can be accepted.

Specific comments:

1. What is the meaning of $Delta DNB$ in Equation (1), citing a text book or a paper may help the reader to understand it.

ΔD_{NB} is now explicitly introduced as “the damage caused by fatigue” in lines 58-59. It has been obtained from Wirsching(1980), which has been cited in line 55.

2. In Equation (3), you have mentioned the Transfer function T between input (Wind) and the generator speed ($Omega_g$, but usually, wind is considered as a disturbance rather an input to a system. You also used in line 88, "disturbance input", so more percisely, in equation (3), it should be disturbance to the system.

In the context of control systems, both control actions and disturbances are considered inputs to the system. However, for more clarity, line 88 has been modified from “disturbance input” to “input”.

3. Please cite a paper or text book to specify "rotor effective wind speed"

A paper by Soltani has been cited, where the concept of rotor effective wind is explained.

4. Line 100, the step 2, it would be eaiser to understand by the reader if you describle a bit more detailed on how to achieve, for example, 1% reduction on the "spectrum" or based on my understanding it is the "output spectrum" at a single frequency.

The reduction is achieved by simple multiplication, as the spectrum is not an analytical function. An explanation is added in lines 101-102.

5. Line 101, how do you compute new fatigue estimation $DOmega 0$ using eqation (2)? You did not mention how do you get G1, G2 and G3.

Dirlik's method offers closed expressions for G1, G2 and G3, which depend on the spectral moments of the load. The expressions appear in the cited references, but have been omitted to improve the readability of the text. Explicitly describing them would entail adding several new equations and parameters to the text that are not fundamental to the results and would be distracting. The full expression for Dirlik's fatigue approximation can easily be found in the literature.

6. The lower plot of Figure 1 shows the fatigue sensitivity ($Delta D%$) as a function of frequency, it only shows that higher frequency results in smaller fatigue sensitivity. But, it does not show what you have mentioned: "higher frequencies lead to higher fatigue". Please explain this statement, because, it would affect the results or the conclusion of your paper.

We understand 'shows that higher frequencies lead to higher fatigue' is not correct and have replaced it by "higher frequencies contribute with more cycles than lower frequencies" which is what we intended to express. (Figure 1 caption).

7. Line 112, "QFT" it is the first time showing this abbrevation, you need to specify it, althought, it is quite obvious for the control engineer to know it refers to "quantitative feedback theory", But for other wind turbine engineers, it is not that obvious.

We have added the full name in line 114.

8. Line 146 You are saying: "wind speed (lower plot)", but the lower plot is not the wind speee, rather "the magnitude o fthe feedback controller". Please comment on this.

We have changed the sentence to make clear that the lower plot refers to the gain of the PI controller (lines 152-153): "Figure 2 shows the magnitude plot of the PI controller (lower plot) operating at a 19 m/s wind speed and its effect on the generator speed and tower base load."

9. In your context, you did not mention Figure 3, so what is the purpose of showing "Figure 3"?

Figure 3 was necessary to understand how closed-loop linear models have been obtained. This piece of information had been forgotten in the first version but has now been included, making the figure relevant.

10. Finally, at Line 152, you mentioned "Quantitative feedback theory" as "QFT", it should be mentioned before when you use "QFT" in the first time.

We have now fixed the mistake by introducing Quantitative Feedback theory before.

11. Line 166, "open-loop transfer function"? I think it should be "close-loop transfer function".

No, bounds are defined for the open-loop transfer function. The loopshaping is also based on the open-loop transfer function.

12. Line 174, "some skills", could you be more precise? what skills?

Skills has been substituted by practice (line 185), which conveys the intended meaning in a more precise way.

13. Line 178, why do yo use four seeds per wind speed? it is fine to say "reducing number of simulations, etc" or cite other paper says, it is enough to use 4 seeds.

To our experience, 4 seeds are enough for an evaluation in a controller design context. Thorough evaluations that are more thorough are typically performed by loads engineers.

14. In general, you should insert a space between number and their units, eg. "19 m/s" rather than, "19m/s".

We have corrected the mistake through the text.

15. Line 185, I don't see there is a large peak at 2.3 rad/s in Figure 1. it is only a small peak, I would say the large peak is at round 1 rad/s, which seems to be the 1st tower mode.

The lower plot of Figure 4 shows a small peak at frequency 2.3 rad/s. Although it is definitely smaller than the first fore-aft mode of the tower, it will contribute to fatigue as well.

16. Now, you mention in Line 190: "Even though the lower frequencies have the greatest impact on the fatigue (see the lower plot in Figure 4) ", which is an counter statement comparing the one that you made for Figure 1. If I compare Figure 1 and 4, they are very similar but you have completely different statements.

We understand 'shows that higher frequencies lead to higher fatigue' is not correct and have replaced it by "higher frequencies contribute with more cycles than lower frequencies" which is what we intended to express. (Figure 1 caption).

17. Line 197: You are saying: "the ROSCO specification is used" for the design of your controller. I would expect that the perform of your controller should be the same as ROSCO controller. So, Why do you expect it is better?

We cannot expect it to be better, we have corrected our text (line 210) "This way, a performance similar to the baseline controller is expected in terms of generator speed regulation."

18. Figure 5 and 6 are very difficult for a non control engineer to understand. Do you think you can use a better representation?

We understand these figures might be somewhat difficult to interpret for engineers without a background in control. However, as they are an exact representation of the design environment we see some value in keeping them as they are. To improve the readability of the document, we have added a description of the Nichols plot in lines 215 to 221: "lpshape is a graphical design tool that represents the bounds and the openloop nominal transfer functions in the Nichols plot (gain in dB agains phase in degrees). The bounds are the limits between the allowed and forbiden values for the open-loop nominal transfer function. They can have different colours, depending on their corresponding frequency, and solid and dashed lines indicating lower and upper limits. The open-loop nominal transfer function is represented by the solid black line and a set of circular

markers at the design frequencies, with the same colour as 220 their corresponding bounds. The design is performed by modifying the position of the markers by adding zeros and poles to the controller."

19. In the whole paper, I don't see the description of your linearized model in term of Equation, etc, and I don't see how do you get the linearized model. You need to add a section on describing your linearized model and how to obtain it.

We have added an explanation in lines 158-159: "The open-loop linear models of the wind turbine have been obtained with the aid of OpenFASTs linearization tool and the closed-loop models have been calculated following the structure represented in Figure 3."

Comments for correcting some writing mistakes:

- Line 45: missing citation
- Line 47: controller's -> controller
- Line 88: 2 time "the disturbance", please remove one.
- Line 130: Sistem -> System
- Line 158: win turbine -> wind turbine
- Line 163: is -> are
- Line 213: sorrounding -> surrounding
- Line 221: meth -> met
- Line 249: smalled -> small
- Line 253: There is no Table 4.4
- Line 258: averave -> average
- Line 259: Table -> table
- Line 260: again -> against
- Line 266: damaged -> damage
- Line 287: bussines -> business
- Table 2, the "mean" column is empty.

All spelling error have been corrected. We have calculated the mean values using a Weibull function. Lines 266-267: "Mean values have been obtained assuming a Weibull distribution in mean wind with shape factor of 2.2 and a scale factor of 11.29." We have also added the mean values to the table.