FACULTY OF ENGINEERING AND ARCHITECTURE

DEPARTMENT OF ELECTRICAL ENERGY, SYSTEMS AND AUTOMATION
LABORATORY SOETE
FINITE ELEMENT MODELLING RESEARCH GROUP

21 September, 2020

Subject: **Examiner (supervisor) report on:**
PhD thesis '**Detection of branched cracks in beam-like structures**' by Eng. Cristian Tufişi.

Dear Mr President of the doctoral committee, Prof. univ. dr. eng Dorian NEDELCU, University „Eftimie Murgu" Reşiţa

Please find below my technical report on the above dissertation.

General appreciation:

Positive comments: The thesis is concerned with an important topic related to damage detection in beam-like structures, with special application to the case of branched cracks. The candidate has carried out different tasks to achieve the objectives of the thesis, including numerical modelling, analytical0 model to detect branched cracks and experimental validation of the developed methodologies. Detecting branched cracks in structures is a challenging task, which has been successfully carried out by the candidate.

The similarity index of the thesis is 24%, which is relatively low compared to other PhD theses. This indicates that there is a lot of potential to publish articles in ISI international journals, which is one the shortcomings of the thesis as mentioned in the negative comments below.

Negative comments: Although the candidate has published five journal articles as it can be seen from page 130 in the thesis, none of these publications has an impact factor. The Romanian Journal of Acoustics and Vibration is ESCI with no impact factor rather than SCIE. As mentioned above, the thesis contains many results that can be published in SCIE journals with high impact factor, which should be the next task for the candidate after his public defence.

Introduction

- The introduction part of the thesis is informative, covers background summary, defines objectives and summarises the content of the dissertation.
- The assumptions made by the candidate are too many, which limits the application of the methodology to a wide range of engineering structures. This means that there will be lots for future works to extend the methodology to other types of damage, beam cross-section, structure, etc. This should be mentioned in future work section at the end of the thesis.
- The thesis outline, its content and organisation look fine.

Chapter 1: The Current State Of Research In The Field Of Vibration Based Damage Detection

- The title of some sections, even the title of the chapter itself, is too long and should be shortened. For example, the title of section 1.1.1 'Local methods used in damage detection methods used in damage detection' would be better written as 'Local methods used for damage detection'.

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- Also, this section, 1.1.1, is very short and superficial and can be extended to provide some details of the local methods.
- Some re-organisation of this chapter many be required. For example, damage detection 1.1.4. Damage detection using natural frequencies and 1.1.5. Methods based on the change of the modal curvature values, are actually part of 1.1.3. Methods based on modal analysis, and should come under this section.
- The crack propagation in concrete structures should not be reported under 1.2.2. Propagation of damages in composite geometries, but a sperate section for concrete structures should be added and extended with more details.

Chapter 2: Numerical Study Of Damaged Beams

- In section 4 ANSYS simulation, the finite element modelling is described in details. However, many information about the model such as total number of nodes, elements and dofs are missing.
- Also, convergence study of the FE model should be conducted. Are the used number of elements enough to get accurate results? Can a coarser mesh still produce good results with less CPU time rather than the expensive fine mesh used in the modal analysis of damaged cantilever beam in section 2.5? Would different crack shapes require different degree of mesh refinement?
- Putting legends in a table, e.g. table 2.7, sounds strange. Legends should be presented in the figure itself. There are also too many data in Figure 2.17, which makes it difficult to follow the effect of right or left crack branches.
- Furthermore, legends should also be added in Figure 2.18. This should be done for all other figures as well.

Chapter 3: A New Predictive Model To Estimate The Frequencies For Beams With Branched

- This chapter presents a methodology, for calculating the natural frequencies of beams with reduced sections. To do so, the candidate applied applying a stiffness reduction model. This mainly make used of analytical solution of cracked beams based on the classical Euler-Bernoulli beam theory.
- The title of this chapter should be rewritten; for example, 'A New Predictive Model For Beams With Branched Cracks'.
- Although the comparison between FEM and the analytical solution seems to be very good, there is no indication of the limitation of the analytical solution. For example, what the limitation in the beam depth and the crack size for using the developed analytical solution?
- Furthermore, what is the effect of the boundary conditions on the results obtained using the analytical solution compared with FEM? In practical, the supports are not rigid and some flexibility should be considered.

Chapter 4: Experimental Research And Validation

- This chapter presents experimental validation of the results obtained by FEM, analytical model and PyDAM software. The experimental tests were conducted at Eftimie Murgu laboratory using damaged and undamaged cantilever beams.

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- Although branched cracks often appear in composite structures, the tested structure was a steel beam. This indicate that experimental tests for composite beams should be planned as an extension of this research for future work.
- The differences between the measured and calculated natural frequencies listed in Table 4.5 should be presented in percentages. Some modes will show high percentage differences, up to 4% - 5%. These should be analysed and commented on in details.
- Similar remark for the damaged beams, the results should be presented and compared in percentage in order to make reliable conclusions.

Chapter 5: Conclusions

- This chapter summarises the main achievements and conclusions of the research work presented in this dissertation.
- A section on future work is missing and should be added. As mentioned earlier, there are many assumptions made by the candidate, which limit the application of the methodology. These assumptions show that there will be lots for future works to extend the methodology to other types of damage, beam cross-section, structure, etc.

In summary, the dissertation can be accepted after major revision as explained above.

If you have any query, please do not hesitate to contact me.

Yours sincerely,

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