

BACHELORS DEGREE ASSIGNMENT SPECIFICATION

Student name:	JIANG	Student P number:	
Programme:	BEng Automotive and Manufacturing streams		
Module:	Advanced Stress Analysis & FEA	Module Level (4, 5, 6):	6
Module code:	M6X00420	Contribution to Overall Module Assessment (%):	50 %
Lecturer:	Kelvin Lake	Internal Verifier:	Rob Goodson
Assignment Title:	Can FEA replace physical testing?	Assignment No (x of x):	1 OF 1
Hand Out Date:	25/02/2020	Submission deadline:	29/03/2020

Referencing:	In the main body of your submission you must give credit to authors on whose research your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have read or quoted in order to complete this assignment (e.g. for books: surname of author and initials, year of publication, <u>title of book</u> , edition, publisher: place of publication).		
Disclosure:	I declare that this assignment is all my own work and that I have acknowledged all materials used from the published or unpublished works of other people. All references have been duly cited.		
Student's Signature:	Assignments will not be accepted without a signature here	Date:	
Turnitin: Lecturer to tick to indicate if an electronic version of the assignment must be submitted to Turnitin. Note: the Turnitin version is the primary submission and acts as a receipt for the student. Penalties for late submission: Up to four weeks late, maximum mark of 40%. Over four weeks late, Refer. Only Year Tutors and the Programme Director may grant an extension.			YES
			✓
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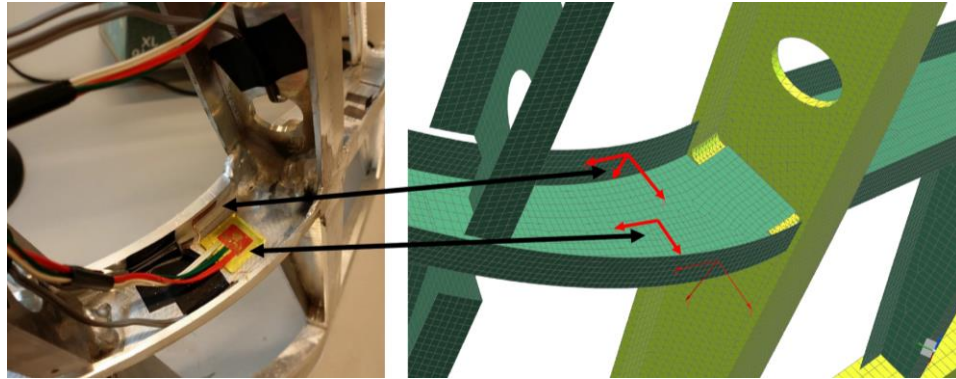
Learning Outcomes tested (from module syllabus)	Assessment Criteria To achieve each outcome a student must demonstrate the ability to:
Demonstrate an ability to analyse a range of engineering problems using advanced stress analysis principles.	

- DO NOT put this form into Turnitin or it will match many similarities with other students' submissions.

TASK DESCRIPTION

This assignment explores FEA and the role that it plays in product development. It is expected that the student will research this topic (referencing any sources used, using Harvard or Vancouver).

GUIDANCE FOR STUDENTS IN THE COMPLETION OF TASKS



The above image shows a component undergoing physical testing and the corresponding FE model. Your task for this assignment is to discuss the following;

1. Why companies typically carryout FE analysis alongside physical testing.
2. How a physical test may be correlated to an FE model.
3. If you think that FE analysis can (or should) ever replace physical testing.

In order to do this, you should consider a case study and use this to discuss the above tasks.

This report should be 3000 words long and should be submitted via moodle

STRUCTURAL SECTION MARKING CRITERIA AND STUDENT FEEDBACK

This section details the assessment criteria. The *extent* to which these are demonstrated by you determines your mark. The marks available for each criterion are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Common Assessment Criteria Applied	Marks available	Marks awarded
1. Research-informed Literature Extent of research and/or own reading, selection of credible sources, application of appropriate referencing conventions.		
(Assessed in point 1)	30	15.9
2. Knowledge and Understanding of Subject Extent of knowledge and understanding of concepts and underlying principles associated with the discipline.		
(Assessed in point 2)	30	17.4
3. Analysis Analysis, evaluation and synthesis; logic, argument and judgement; analytical reflection; organisation of ideas and evidence		
(N/A)	0	
4. Practical Application and Deployment Deployment of methods, materials, tools and techniques; application of concepts; formulation of innovative and creative solutions to solve problems.		
(Assessed in point 3)	30	17.4
5. Skills for Professional Practice Attributes in professional practice: individual and collaborative working; deployment of appropriate media; presentation and organisation.		
(Assessed in report presentation and structure)	10	6

Assignment Mark Overall (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)	Late Submission Penalties (tick if appropriate)		56.7 %
	Up to one-week late		
	Over one week late		

COMMON ASSESSMENT AND MARKING CRITERIA

	OUTRIGHT FAIL	UNSATISFACTORY	SATISFACTORY	GOOD	VERY GOOD	EXCELLENT	EXCEPTIONAL
Assessment Criteria	0-29%	30-39%*	40-49%	50-59%	60-69%	70-79%	80-100%
1. Research-informed Literature Extent of research and/or own reading, selection of credible sources, application of appropriate referencing conventions	Little or no evidence of reading. Views and findings unsupported and non-authoritative. Referencing conventions largely ignored.	Poor evidence of reading and/or of reliance on inappropriate sources, and/or indiscriminate use of sources. Referencing conventions used inconsistently.	References to a limited range of mostly relevant sources. Some omissions and minor errors. Referencing conventions evident though not always applied consistently.	Inclusion of a range of research-informed literature, including sources retrieved independently. Referencing conventions mostly consistently applied.	Inclusion of a wide range of research-informed literature, including sources retrieved independently. Selection of relevant and credible sources. Very good use of referencing conventions, consistently applied.	A comprehensive range of research informed literature embedded in the work. Excellent selection of relevant and credible sources. High-level referencing skills, consistently applied.	Outstanding knowledge of research-informed literature embedded in the work. Outstanding selection of relevant and credible sources. High-level referencing skills consistently and professionally applied.
2. Knowledge and Understanding of Subject Extent of knowledge and understanding of concepts and underlying principles associated with the discipline.	Major gaps in knowledge and understanding of material at this level. Substantial inaccuracies.	Gaps in knowledge, with only superficial understanding. Some significant inaccuracies.	Evidence of basic knowledge and understanding of the relevant concepts and underlying principles.	Knowledge is accurate with a good understanding of the field of study.	Knowledge is extensive. Exhibits understanding of the breadth and depth of established views.	Excellent knowledge and understanding of the main concepts and key theories. Clear awareness of challenges to established views and the limitations of the knowledge base.	Highly detailed knowledge and understanding of the main theories/concepts, and a critical awareness of the ambiguities and limitations of knowledge.
3. Analysis Analysis, evaluation and synthesis; logic, argument and judgement; analytical reflection; organisation of ideas and evidence	Unsubstantiated generalisations, made without use of any credible evidence. Lack of logic, leading to unsupportable/missing conclusions. Lack of any attempt to analyse, synthesise or evaluate.	Some evidence of analytical intellectual skills, but for the most part descriptive. Ideas/findings sometimes illogical and contradictory. Generalised statements made with scant evidence. Conclusions lack relevance.	Evidence of some logical, analytical thinking and some attempts to synthesise, albeit with some weaknesses. Some evidence to support findings/ views, but evidence not consistently interpreted. Some relevant conclusions and recommendations, where relevant	Evidence of some logical, analytical thinking and synthesis. Can analyse new and/or abstract data and situations without guidance. An emerging awareness of different stances and ability to use evidence to support the argument. Valid conclusions and recommendations, where relevant	Sound, logical, analytical thinking; synthesis and evaluation. Ability to devise and sustain persuasive arguments, and to review the reliability, validity & significance of evidence. Ability to communicate ideas and evidence accurately and convincingly. Sound, convincing conclusions / recommendations.	Thoroughly logical work, supported by evaluated evidence. High quality analysis, developed independently or through effective collaboration. Ability to investigate contradictory information and identify reasons for contradictions. Strong, persuasive, conclusions, justifiable recommendations.	Exceptional work; judiciously selected and evaluated evidence. Very high quality analysis, developed independently or through effective collaboration. Ability to investigate contradictory information and identify reasons for contradictions. Highly persuasive conclusions
4. Practical Application and Deployment Effective deployment of appropriate methods, materials, tools and techniques; extent of skill demonstrated in the application of concepts to a variety of processes and/or contexts; formulation of innovative and creative solutions to solve problems.	Limited or no use of methods, materials, tools and/or techniques. Little or no appreciation of the context of the application.	Rudimentary application of methods, materials, tools and/or techniques but without consideration and competence. Flawed appreciation of the context of the application.	An adequate awareness and mostly appropriate application of well established methods, materials, tools and/or techniques. Basic appreciation of the context of the application.	A good and appropriate application of standard methods, materials, tools and/or techniques. Good appreciation of the context of the application, with some use of examples, where relevant.	A very good application of a range of methods, materials, tools and/or techniques. Very good consideration of the context of the application, with perceptive use of examples, where relevant. Evidence of some innovation and creativity.	An advanced application of a range of methods, materials, tools and/or techniques. The context of the application is well considered, with extensive use of relevant examples. Application and deployment extend beyond established conventions. Innovation and creativity evident throughout.	Outstanding levels of application and deployment skills. Assimilation and development of cutting edge processes and techniques.
5. Skills for Professional Practice Demonstrates attributes expected in professional practice including: individual initiative and collaborative working; deployment of appropriate media to communicate (including written and oral); clarity and effectiveness in presentation and organisation.	Communication media is inappropriate or misapplied. Little or no evidence of autonomy in the completion of tasks. Work is poorly structured and/or largely incoherent.	Media is poorly designed and/or not suitable for the audience. Poor independent or collaborative initiative. Work lacks structure, organisation, and/or coherence	Can communicate in a suitable format but with some room for improvement. Can work as part of a team, but with limited involvement in group activities. Work lacks coherence in places and could be better structured.	Can communicate effectively in a suitable format, but may have minor errors. Can work effectively as part of a team, with clear contribution to group activities. Mostly coherent work and is in a suitable structure.	Can communicate well, confidently and consistently in a suitable format. Can work very well as part of a team, with very good contribution to group activities. Work is coherent and fluent and is well structured and organised.	Can communicate professionally and, confidently in a suitable format. Can work professionally within a team, showing leadership skills as appropriate, managing conflict and meeting obligations. Work is coherent, very fluent and is presented professionally.	Can communicate with an exceptionally high level of professionalism. Can work exceptionally well and professionally within a team, showing advanced leadership skills. Work is exceptionally coherent, very fluent and is presented professionally.

Student Self Evaluation Form

Student name:		Student P number:	
Programme:		Year of programme	
Assignment Title:			

This section repeats in brief the common assessment criteria detailed on previous pages. The *extent* to which these are demonstrated by you determines your mark. Using these criteria, tick the box that best indicates the level of achievement you feel you have achieved with regard to each of them.

Common Assessment Criteria Applied	Level of Achievement						
	REFER		3 rd	2:2	2:1	1 st	1 st
	OUTRIGHT FAIL	UNSATISFACTORY	SATISFACTORY	GOOD	VERY GOOD	EXCELLENT	EXCEPTIONAL
1. Research-informed Literature	0-29% ☐	30-39% ☐	40-49% ☐	50-59% ☐	60-69% ☐	70-79% ☐	80-100% ☐
2. Knowledge and Understanding of Subject	0-29% ☐	30-39% ☐	40-49% ☐	50-59% ☐	60-69% ☐	70-79% ☐	80-100% ☐
3. Analysis	0-29% ☐	30-39% ☐	40-49% ☐	50-59% ☐	60-69% ☐	70-79% ☐	80-100% ☐
4. Practical Application and Deployment	0-29% ☐	30-39% ☐	40-49% ☐	50-59% ☐	60-69% ☐	70-79% ☐	80-100% ☐
5. Skills for Professional Practice	0-29% ☐	30-39% ☐	40-49% ☐	50-59% ☐	60-69% ☐	70-79% ☐	80-100% ☐

PLEASE COMMENT ON AREAS IN WHICH YOU FEEL THAT YOU HAVE PERFORMED WELL	PLEASE COMMENT ON AREAS YOU FEEL THAT YOU NEED TO DEVELOP

Student's Name		Date	
Student's Signature			

University of Wales Trinity Saint David

School of Engineering

Can FEA Replace Physical Testing?

Xiaotong Jiang

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Year 3

24/04/2020

Advanced Stress Analysis & FEA(M6X00420)

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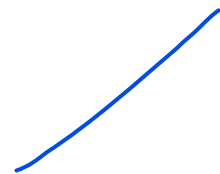
1. Introduction

The report mainly puts emphasis on the relationship between FEA which represents the strong and advanced virtual analyzing tool and real-world physical testing. With the rapid development of the computational analysis software, FEA gradually becomes an essential and popular tool in the designing and producing process of the product. With FEA, convenience can be provided considering that FEA enables people to predict the issues of model designing, results in the less test analysis time, lower test cost, and also improves the rate of success before the real-world prototyping.

In this report, the author explained and discussed three different aspects of the relationship between FEA and physical testing. Firstly, from companies' perspectives, the author discussed how the combination of these two bring the greatest benefit and efficiency to the company.

Secondly, the correlation needs to be explained to indicate how physical testing works on the FE model. Theoretical analysis about their correlation was conducted by the author, and also a case was conducted and showed to illustrate it.

For the last topic, the question whether FEA is the substitute for the physical test, in fact, is an open topic. The author began from his own perspective and explained it from both sides.



2. Companies' preference- FEA together with physical testing

2.1 The definition of FEA (Finite Element Analysis)

FEA is a method which could analyze the performance of parts or assembly throughout their life cycle. One of its function which is provided for people is to anticipate potential design problems, thereby minimizing risk to the product, profits, and your business (Caliber Design, 2015).

Nowadays it is not uncommon to find that FEA has gradually becomes an efficient way during the process of company's production, which is also accompanied by the physical testing. From the author's perspective, FEA shows both merits and demerits over the physical testing. However, for the companies, FEA along with physical testing could create the highest profit and provide customers with maximum protection.

2.2 The effects of the combination between FEA and physical testing

For the company, not only the quality and detailed performance of the product need to be considered, but also the consumer perception and the cost and time of the product are included into the design.

2.2.1 The reducing demand of the physical testing prototype after assessing the consistence

From Changan automobile technology center, one staff called Dinglu once applied FEA model of a mini-truck which was established to analyze the FEM modal frequencies of BIW, using the MSC. Nastran and MSC.Patran software. At the same time, he also did the physical testing to assess the consistent between these two ways for the modal analysis.

In automotive product design, it is very important to grasp the dynamic characteristics of the designed product in advance and design the product from a dynamic perspective so that the products involved meet the dynamic requirements (Zhou, 2002). During the two modal analysis methods, Dinglu held the attitude that the FEM needs to have high accuracy and then the result was credible. Finally, he compared two results and obtained the consistence which meant the FEA analysis could be applied to the product design.

Hence, FEA together with the physical testing, to a large extent, could assess the reliability and accuracy about the FEA compared with the physical testing results. Then after the verification this part of the analyzing task could use FEA to substitute testing modal analysis in laboratory

and even apply it before the prototype producing to reduce the cost and time spent in the physical testing. However, in order to further study the dynamic characteristics of the car, other content analysis and detailed experimental analysis of the car must be carried out and FEA must be along with the physical testing.

To be concluded, the companies choose FEA with physical testing to assess the reliability of FEA to decide whether FEA could replace the physical test in the same process or task to minimize the cost and time.

2.2.2 FEA and physical testing shows the strong test facility and improve the consumer perception of the product

For the GKN company, its website shows the advanced and world class test facilities like hub systems testing, structures testing which are shown below.

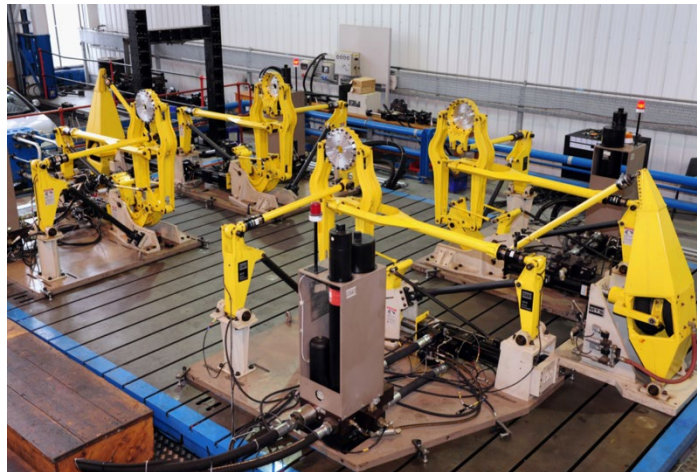
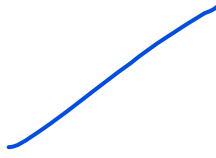


Fig 2.1 structure testing at GKN (Test Facilities - GKN, 2020)



Figure 2.2 hub systems testing (Test Facilities - GKN, 2020)

Most companies such as GKN spend lots of time and cost on the test facilities which covers



computational tools (FEA) and laboratory test (physical test).

As to GKN company, it applied a wheel test which conducts tests in the real-world environment, hub and wheel tests can simulate almost any operating conditions to provide accurate performance data, which is beneficial to customers and contributes to improve the customer perception of the product, and also, in other aspects, provides a basis for its further manufacturing, development and investment plans (Test Facilities - GKN, 2020).

For the wheels test facilities, GKN sets FEA tools, field testing, data acquisition etc. These facilities cover both FEA and physical testing to improve its strong test capacity and high-quality products. Also, FEA along with physical testing could provide the company with more competitiveness in the market.

To be concluded, FEA could provide enterprises with lower cost and time on the real-world test and high-efficient work to accelerate products to be applied in the market, while the physical test is also a strong tool to show the advanced test facilities and excellent or even extreme performance of products to improve the satisfaction of customers. FEA alongside with physical test, at a large extent, could create the biggest profit for companies.

2.2.3 Initial comparison of test and FEA help assumptions evolve

When doing the FEA and physical testing, results can be compared to minimize the error during the process of the product designing. And for early program comparisons, which can help plans and assumptions evolve. Many companies use FEA to predict strength and stiffness of physical testing fixtures, considering that the interaction between fixture and product is inevitable but it can be quantified (Abbey, 2015). And the quantified interaction can be the dynamic interaction or fixture flexibility. In this way can the companies accelerate to conduct the development of the designing product.



3. Correlation between FE model and physical testing

The relationship between a physical test and an FE model has become a topic to talk about and do the research in this report. From the author's perspective, there is a relationship about validation between physical test and FE model.

3.1 Verification and Validation

When it comes to FEA, verification and validation seem to be a vital part among mathematical method, FEA and physical testing. In 2005, Tony Abbey once did the discussion and task about what verification and validation are in relation to the FEA.

3.1.1 Definition

Firstly, for the definition of verification and validation, the American Society of Mechanical Engineers (ASME) and the Los Alamos National Laboratory (LANL) both gave the agreed definitions. "The process of determining that a computational model accurately represents the underlying mathematical model and its solution", ASME defines verification, while LANL also gives the similar definition that it shows the function of evaluating that the FE model could accurately represent developers' initial design, computational method and solution about the model.

And for the validation, ASME believes that validation is the process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model. They both hold the attitude towards physical test that can play a validation role for the FE model.

3.1.2 Correlation

(1) Flow chart

ASME once created a chart where the relationship between verification, validation, FE model and physical testing can be concluded and described. It is shown below.

Anticipating the physical results of the model is one of the crucial part of verification (Abbey, 2015). In addition, the initial assumptions about the FE model like modeling details, boundary conditions, accurate loads and constraints need to be estimated and thought as the part of the verification.

In fact, FEA is an integrated process between computational analysis and physical testing

disciplines.

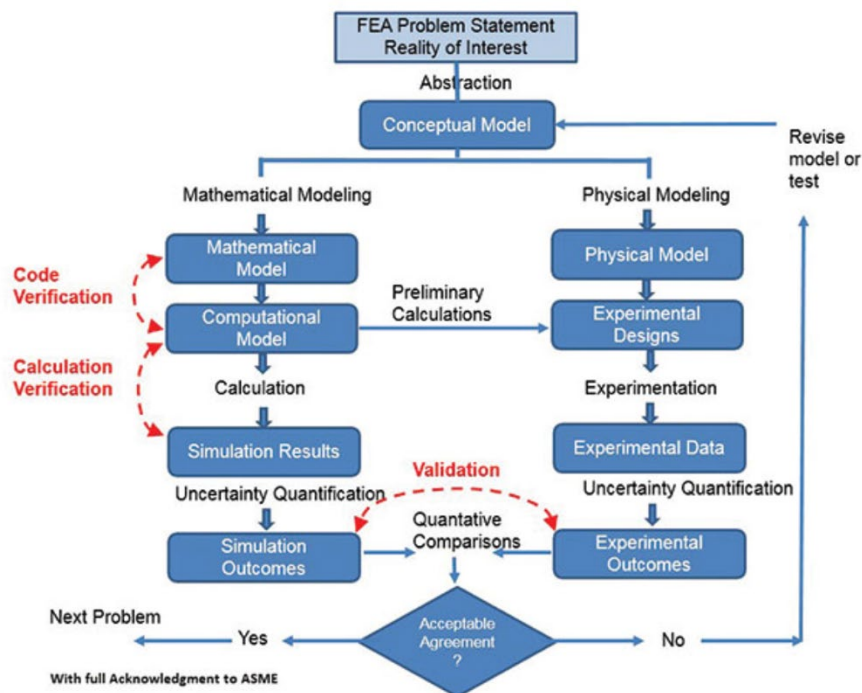


Figure 3.1 Verification & validation flow chart (Leonard, 2007)

(2) Validation section

The physical testing is correlated with FE model through the validation process. The validation process can be divided into 2 parts:

1. Conducting the experiments to estimate whether the model have the capability which is predicted in the designing stage.
2. Assessing the accuracy by quantifying the comparison of experimental and simulated results (Leonard, 2007).

(3) Uncertainty quantification

From the flow chart, a process called uncertainty quantification can be found in FEA and physical testing procedures. This uncertainty quantification is attributed to the error which may be classified as being either random error or systematic error. A meaningful comparison should be conducted with a comprehensive estimate of the uncertainty in FE mode and physical testing, and assess these two uncertain outcomes (Leonard, 2007).

For the uncertainty, on the one hand, the simulated model has limitations. On the other hand, for the test method, people could not guarantee the accuracy and consistency of the test. For example, for some drop analysis, due to the influence of the gap, the simulation value will be

lower than the test value. If the simulation and the test are very close, one of them should be wrong.

(4) Validation metrics

In fact, in the validation process, comparisons between test and FEA results are based on a set of metrics. And the fact is that validation becomes better as the number of metrics increase, which means that the big and single comparison (such as material's yield strength or maximum deflection) is supplemented by many metrics (Abbey, 2015). More metrics can provide a broader validation between FE model and physical test. After applying these metrics, the result should be a quantitative assessment of the agreement between FEA and test (Leonard, 2007). Finally, according to the metrics, the relative error between FE model and test can be obtained and submitted to the decision maker to determine the effectiveness of the model for its intended use in the decision-making process.

3.2 Application

The correlation between FE model and physical testing serves as an important part to minimize the differences between the test outcomes and the FEA predictions by adjusting the FE model (such as boundary conditions, loads). For static and dynamic load analysis, test results for specific load conditions can be correlated to verify model predictions.

The author is doing the project which is concerned with both FEA and physical tests. For the aim of this project, the torsional stiffness of a vehicle structure should be tested and analyzed in respectively real-world and SOLIDWORKS. And the final goal is to accomplish the optimization of the model in the computational software. For these project, it subtly indicates the relationship between FEA and physical testing as followed.

For the FE model, the author with her classmates together calculated the relative parameters of the vehicle and then according to these data they built an FE model in SOLIDWORKS.

For the torsional stiffness testing process in real life, there are 10 points on the chassis to test. In the test, the author applied 65 kg on the bar to twist the vehicle. The bar was linked with the whole chassis through bolts. And the rear part of the chassis was fixed to the ground. The process of the physical test can be found in the following pictures.

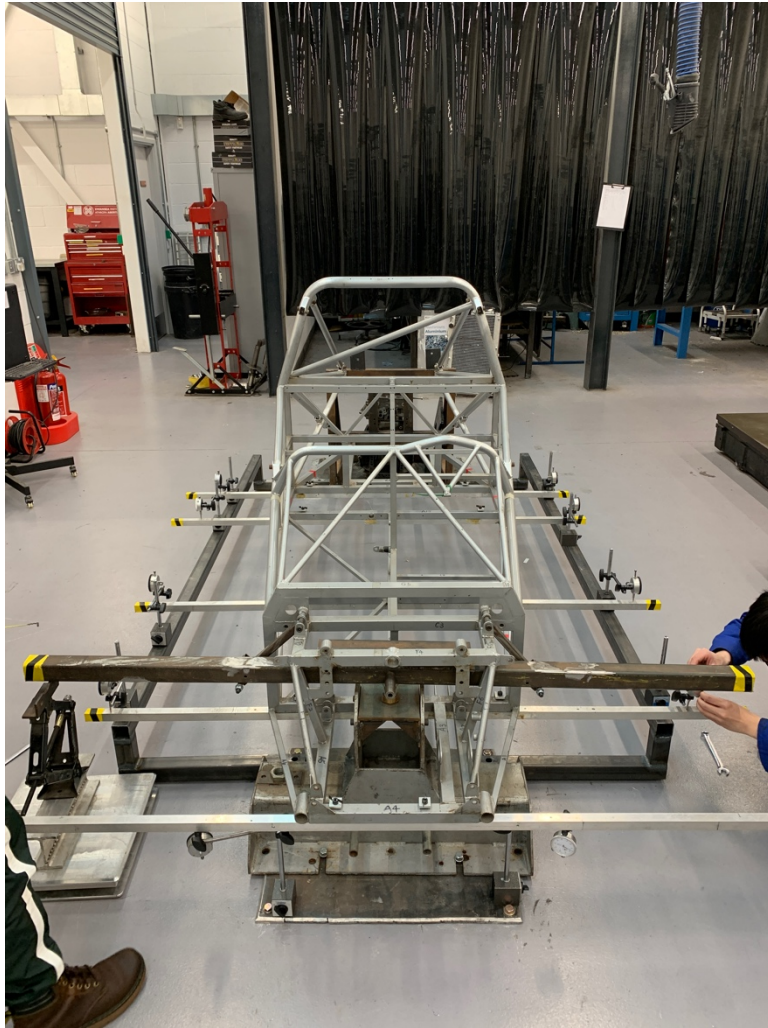


Figure 3.2 torsional stiffness (physical testing)

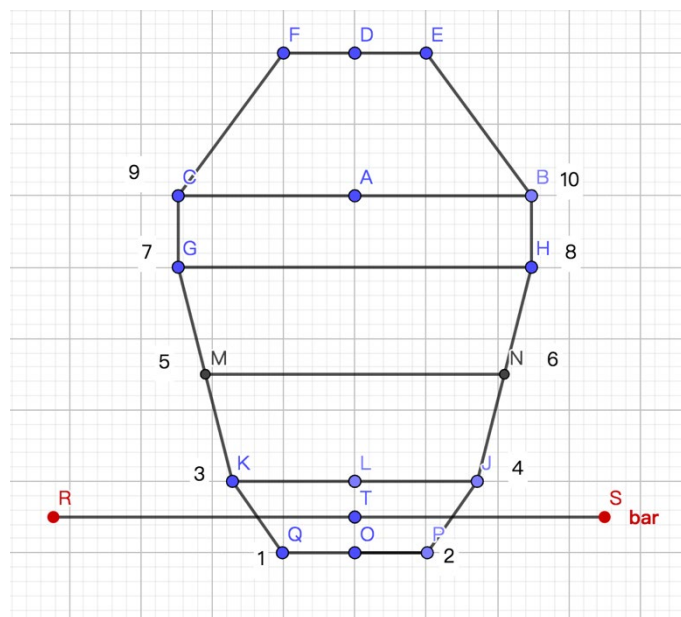


Figure 3.3 Simplified model

To conclude and simplify the test, the task was calculated 10 displacements from the 10 points,

and convert the measured displacements value into rotated angles, through mathematical calculations.

		65kg on the bar	Displacement/Distance ($\tan\theta$)
I	1	2.942mm	0.0063
	2	2.25mm	
II	3	4.018mm	0.00518
	4	4.018mm	
III	5	3.069mm	0.00374
	6	3.07mm	
IV	7	2.03mm	0.0024
	8	1.779mm	
V	9	1.74mm	0.0020
	10	1.380mm	

Table 3.1 Physical testing data

For the FE model, firstly, the author needs to do the basic calculations of the model, like relative parameters, actual loads applied to the vehicle itself, and particularly the intended result of the chassis. The author built the model in the SOLIDWORKS and the mesh also was created in the following pictures.

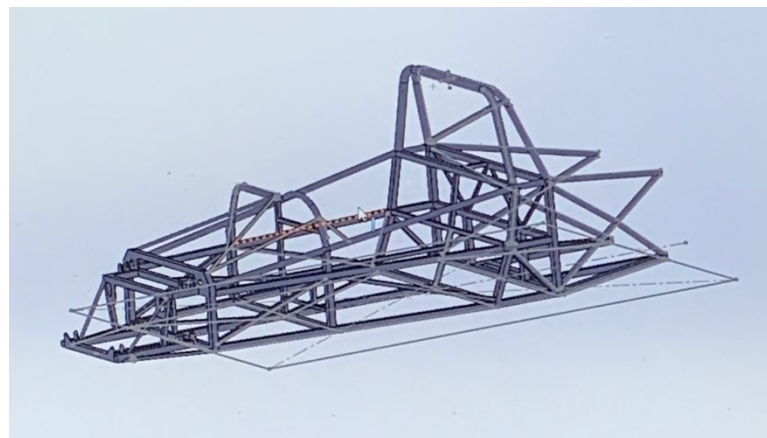


Figure 3.4 The model created in the SOLIDWORKS

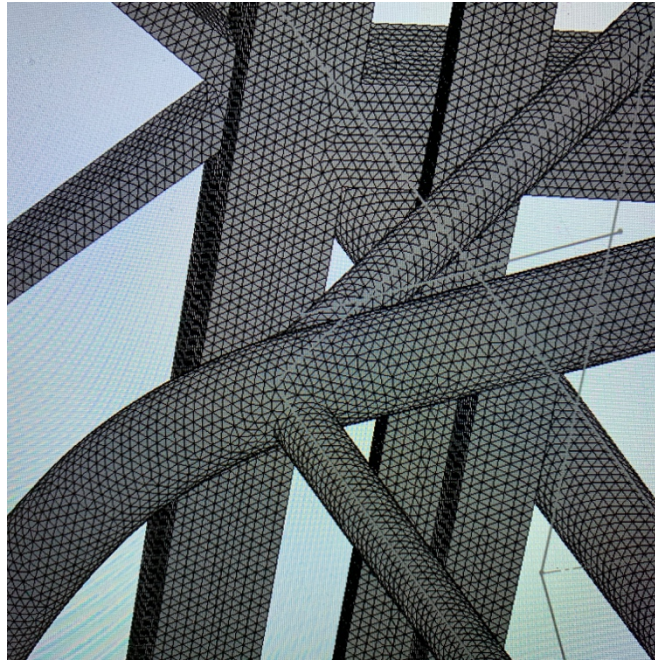


Figure 3.5 Mesh in SOLIDWORKS

In fact, mesh could exert a tremendous effect on the outcomes of FEA by influencing the accuracy of the model. However, the mesh convergence can almost ensure its accuracy to FEA local stresses. And for the value of the force which needs to be added to the vehicle, the author measured the length of bar and distance between the stress point and middle line to calculated the actual force (2403N). Hence, the transferring force is a point where FEA may easily fall in the trap. The author chose the relative points to obtain the displacements in the computational FEA outcomes, and compared the results with the physical testing one.

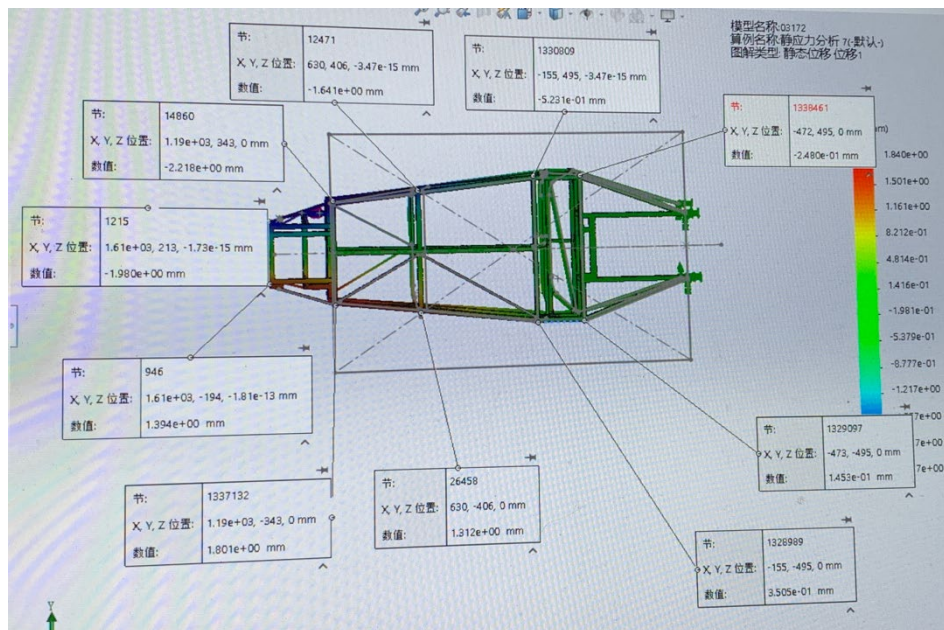


Figure 3.6 Choosing 10 points' displacement

		FEA Displacement/Distance ($\tan\theta$)	Physical testing Displacement/Distance ($\tan\theta$)
I	1	0.0083	0.0063
	2		
II	3	0.0058	0.0052
	4		
III	5	0.0036	0.0037
	6		
IV	7	0.0088	0.0024
	8		
V	9	0.0038	0.0020
	10		

Table 3-2 Comparative table for the torsional angle

Through the comparative table between FE model outcomes and physical testing outcomes, the sets of IV, V have some problems. From the author's intended outcome, the area closer to the rear part, the more stiffness it may have. And this two part statistics show that in FEA the torsional angle is bigger than the physical one. Nevertheless, no matter FEA or physical testing, they all have the uncertainty quantification or the error. Hence, they cannot be much similar to each other.

The author gave a deep thought about why some FEA outcomes cannot be right with the predicting outcomes. The author found that in FEA the model was fixed with just 4 faces of the rear vehicle, but in reality, the chassis was fixed with the ground by the clamping device.

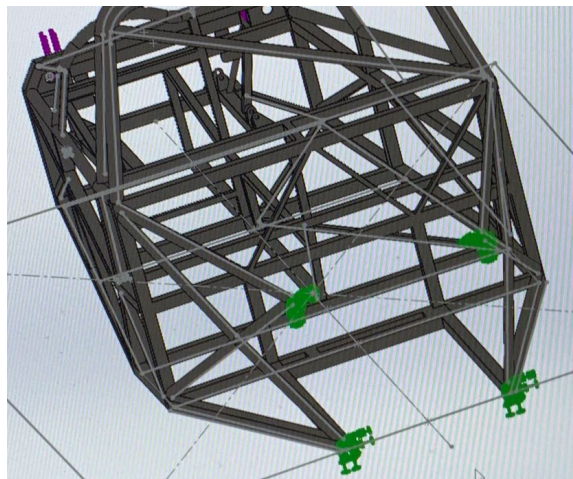


Figure 3.7 Fixtures in SOLIDWORKS

As mentioned above, the relative interaction between fixtures and chassis cannot be neglected. Hence, the author needs to adjust the FE model by adding the clamping device.

4. Can FE analysis ever replace physical testing?

FEA is the product of the increasingly development of technology and highly demand of efficient companies. The emergence and rapid development of FEA have caused a certain impact on the product design and production methods. Previously physical testing is the only key point to assess the product quality, but it may cost much time, labor and money. Nowadays, some people have suggested whether FEA can directly replace physical tests for product analysis. The author will discuss this topic in terms of discussing the merits and demerits of FEA.

4.1 The advantage of FEA

(1) FEA can provide a sight where the effects which real world extremes will exert on the product designing process are analyzed and simulated, which could save the cost and time because of the smaller demands and trials of the real world physical prototypes (Caliber Design, 2015).

(2) FEA can also be applied to the optimize or modify the performance of a product. Before the physical prototyping of a new product being produced, FEA can anticipate the mechanical properties of the product which provide theoretical basis for the design (Zhou, 2002). For the companies, it will be worth to the business to predict the potential problems which could reduce the warranty claims and make consumers aware of it.

4.2 The disadvantage of FEA

(1) To get a stress plot through FEA is not difficult, but the accuracy of the results needs to be considered and even validated seriously. Generally, the accurate analysis happens when analyst combines experience and engineering judgment with it.

(2) Mesh quality exerts enormous effects on the FEA outcomes. A coarse mesh may cause the inaccurate stress while an exactly fine mesh may take long time to run and solve.

(3) Boundary conditions, incorrect restraints or load may influence the outcomes. The FE model can easily be made mistakes once one step of the assumption is wrong (Test Facilities - GKN,

2020).

4.3 Two independent ideas

From the author's perspective, FEA and physical are two independent ideas for verifying phenomena. There is no more essential relationship between the two methods. The FEA has its own set of procedures and programs. As long as the FEA personnel are true and accurate about the FE model, the boundary and other simulation processes, the FEA results are referenced. And the FEA is the process of solving partial differential equations, so one FEA is one time. The solution process is an experiment on the process of partial differential equations. As for the actual physical test, it is impossible for the test to achieve a 100% reduction of the actual result. It is only a special test and verification for special circumstances, and then forms a design criterion. In addition, Due to the limitation of the device like test instruments, loading and extraction, etc. the error of the test is greater than the error of the FEA in some cases. On the other hand, it is also noted that FEA and physical testing must be complementary to each other. The complementary simulations serve to improve the FEA and test schemes, and ultimately can be used as a predictor to avoid actual dangerous situations.

In conclusion, the author holds the attitude that it is that there is no FEA that can replace physical tests. They are all independent individuals. If they can be analyzed together, the maximum benefit can be achieved. Physical testing could be the validation process for the FEA which can minimize the test required to save cost and time, but FEA could not be the substitute for the final test.



5. Conclusion

In this report, the author discussed three questions which are all concerned with the relationship between FEA and physical testing.

For the question one why companies choose to do the FEA together with physical testing, the author listed three explanations. Firstly, when FEA was validated with the physical testing, FEA can be repeated for the same analysis to reduce the physical tests required and costs. Secondly, these two together can improve the consumers' perception of the product. Finally, early comparisons between them before the physical prototyping could contribute to the evolving of the assumption for the product designing stage.

Then the author explained the verification and validation between FE model and physical testing. And the author detailed the validation process to express the correlation. The validation process is concerned with FEA and test, but it is important to notice these two uncertainty quantifications which should be compared to validate whether the FE model could realize the predicting capability.

For the last topic, the author held the attitude that FEA cannot replace the test because they are respectively independent ideas to deal with the performance of the product. They both have its advantages and limitations. The author particularly believed that the condition when FEA and physical testing are complementary to each other makes the best profit.

INTERESTING REPORT, ALTHOUGH QUITE SUBJECTIVE IN PLACES. AUDIO USING SUBJECTIVE TERMS. GOOD ANALYSES, ALTHOUGH THIS DOES NOT ACTUALLY ADDRESS THE BRIEF.

6. Reference

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