

BACHELORS DEGREE ASSIGNMENT SPECIFICATION

Student name:	<i>Lj</i>	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I declare that this assignment is all my own work and that I have acknowledged all materials used from the published or unpublished works of other people.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:	<i>Assignments will not be accepted without a signature here</i>	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
			✓
			NO

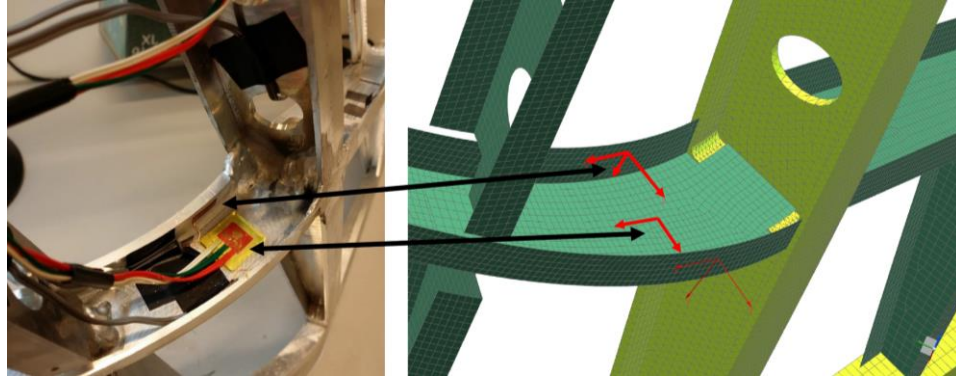
Learning Outcomes tested (from module syllabus)	Assessment Criteria To achieve each outcome a student must demonstrate the ability to:
Demonstrate an ability to analyse a range of engineering problems using advanced stress analysis principles.	

- 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	18.6
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	19.2
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	18.3
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	6.4

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)		62.5 %
	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?

Yan Li

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Level 6

27/04/2020

Advanced Stress Analysis & FEA

M6X00420

Kelvin Lake

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1 Introduction

In this report, author will research the role FEA plays in product development. Finite element analysis, also called FEA, is becoming the industry standard tool to design and optimize the product. What's more, FEA is always carried out with physical testing under same load conditions. The correlation between FE model and physical testing makes FEA a realistic research tool and been widely used. Not only the literature research, this study is also carried out based on a real case of the lightweight work of a chassis. Both FEA and physical testing are used to test the torsional stiffness to validate the CAD model, which is shown in Figure 1-1.

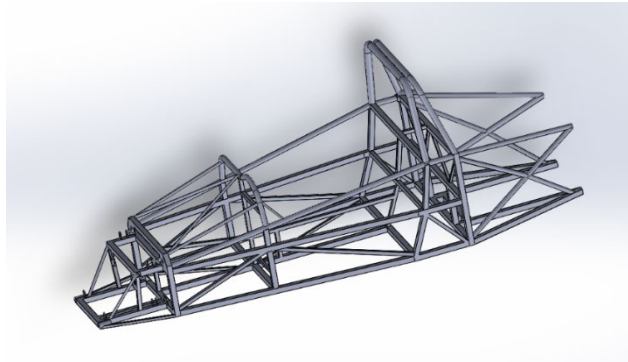


Figure 1-1 Chassis CAD model

Papers about company's product development work using FEA and physical testing in different industries are used to find the reason of this common tool. Through the study process, the characteristics of this tool can be found by comparing various company's researches. In addition, the role physical testing played can also be found. Based on chassis' work, author is going to explain why companies typically carryout FE analysis alongside physical testing.

According to previous research, how the physical test correlated to the FE model can be explained. How they work together to help the development process in various industries is the core parts of this tool. Work about chassis also provides a powerful argument to explain how the correlation is built.

Finally, author will discuss whether the FE model can ever replace physical testing. Analysis about the importance of the physical testing in product development gives some advice to this question. According to the work in papers and author's case, from author's perspectives, physical testing is the basis of FE model. It provides basic data, limitation and can validate and verify the FEA results. Therefore, it can't be replaced.

2 Background

Finite element analysis is a tool using finite element method (FEM) to study and analysis a phenomenon. FEA is particular numerical tool of solving various equation on two or three space variables and is widely used to solve problems in typical areas including structural analysis, heat transfer, fluid flow, electromagnetic potential and mass transport (Elements, 2020). In order to solve problems, FEM subdivides a large system into simpler and smaller parts, called finite elements, which is realized by meshing the target object. Then, the problem will be converted into a lager system of equations of the whole problem. Finally, FEM takes use of variational methods to approximate a solution (Logan, 2011). Engineers apply the finite element method (FEM) through using FEA computer software which provides critical insight into a design's performance prior to physical testing. (ASR, 2020)

The real case carried out by author is an optimization work based on a race car chassis. First of all, author measures the dimensions of chassis then create a same CAD model in SolidWorks. Torsional stiffness of chassis is test in SolidWorks Simulation module, and measuring the displacements under a torque of specific magnitude to calculate the torsional stiffness. In addition, the stiffness is also been calculated. Then optimize the model in terms of the difference between FEA and physical test results.

3 Company' s Research

FEA has been used by many companies to develop the product.

Fatih KARPAT design a Rollover Protective Structure (ROPS) for agricultural tractors. FEA is carried out in RADIOSS software. Difference of displacement results of simulation and physical testing is compared to maintain the strength and validation of the structure. There is a strong correlation between FEA and physical test, which makes it possible to predict the behaviour of the structure in design process, reducing the prototype and test cost. (Fatih KARPAT, 2018)

As an important vehicle interior trim, door trims can reduce external noise and provide objects storage, also accord with ergonomic concepts. Because of its structural function, heat stakes are widely used as connectors. FEA combining with physical testing is an economic and efficient method to develop a structural component. For the heat stakes, through numerical simulation, loads put on the heat stakes under different conditions shows the maximum load. Therefore, the best heat stakes location layout can be determined, which gurantees the high quality and satisfies customers' requirements. Tiago use Kratos KE 2000 MP to test two types heat stakes' maximum retention force, which is set as the upper limit of load heat stakes can provide when the pull handle under 600N loads in FEA (shown in Figure 3-1). Finally, this tool is proved to be practical in the door trim development process (Tiago Sartor, 2015).



Figure 3-1 FEA and Physical Test Diagram

According to the new vehicle specifications, when the vehicle striked by a fully loaded oncoming vehicles, the rear bumper of new E-Z-GO golf vehicle must withstand certain corner impacts without visual damage. In order to meet new specifications, redesign work including retooling, physical prototype and crash testing must be carried in lowest cost and as short a period of time as possible. Jingheng Wen takes use of correlating FEA with test to design a new bumper. There are 3 testing and 2 FEA models: field crash testing and lab quasi-static testing for original reinforced rear bumper, validation test for final redesigned bumper, crash simulation models relevant with test data involoving original reinforced rear bumper FEA

model and new designed FEA model, one implicit analysis model in ANSYS Workbench and one explicit analysis in LS-Dyna. The critical point of FEA model is accuracy. Correlating FEA with test can help simplify model by applying the proper boundary condition and material properties. It's a relatively easy and fast tool, which is especially suitable for products produced by complex material. Figure 3-2 below shows the simplify FEA model and physical testing (Jingheng Wen, 2011).

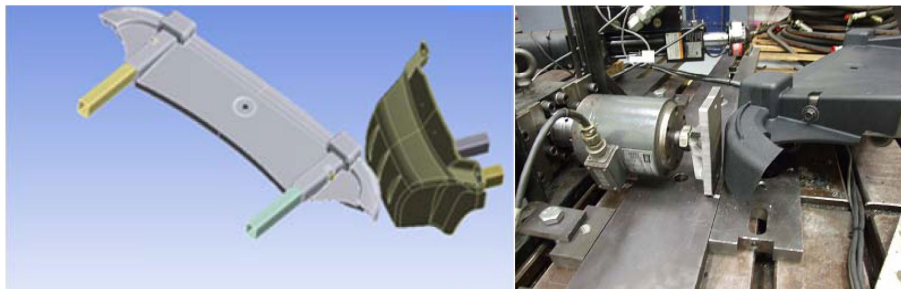


Figure 3-2 Simplify FEA model and physical testing

The durability performance of vehicle hood components should be good enough to support the vehicle hood works normally. With the highly competitive and rapidly evolving automotive industry, companies have to put the highly quality products to market as fast as possible at a lower cost. Shailesh and his teams plan to use CAE methodology to replace the physical test, relying on FE model to optimize the component. Therefore, there is no need to manufacture the expensive prototypes and do the time consuming physical testing. And the physical testing is required only to validate the final design layout. Figure 3-3 shows the final physical test (Bayani, 2011).

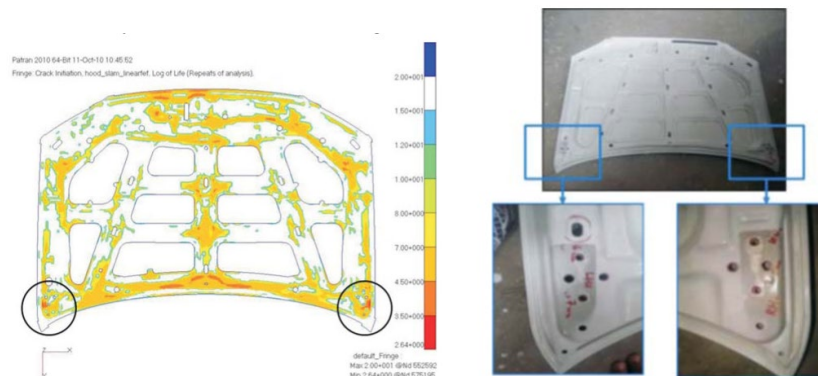


Figure 3-3 FEA and physical testing results

Joint technology plays an important role in transmitting structural loads, and mechanical fastener joints including blind rivets is widely used in industries. Generally, two types failures are observed in mechanical fasteners: tensile and shear failure, also other failure models like tension, shear-out, cleavage, pull-out and bearing are observed. In order to understand the

failure mechanisms, Billy takes use of FE methods to model the failure mechanisms of fasteners in tensile and shear failure. What's more, it's necessary to validate the FE modelling process in order to put the software package to market. Comparison between FEA results and physical testing results is widely used to validate the package. In this research, FEA results output from MSC.MARC/Mentat FEA package are compared with results output from 6.4mm diameter blind rivet in terms of BS EN ISO 14589:2001. And the process is validated can work perfectly, Figure 3-4 below shows the FE and physical testing model (Costello, 2004).

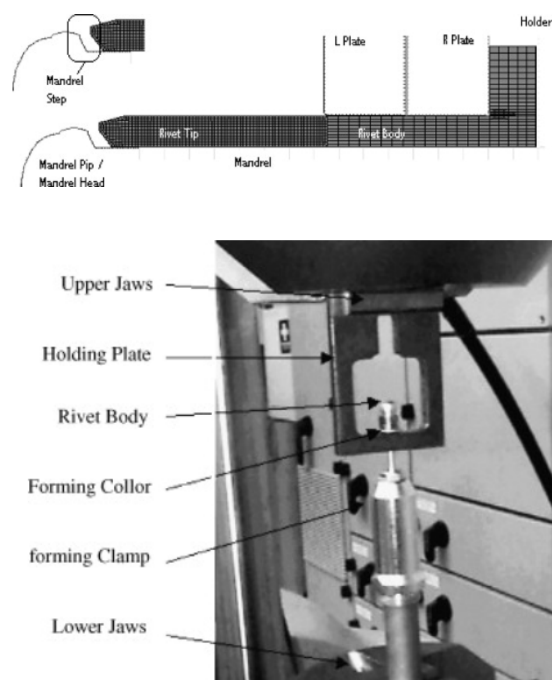


Figure 3-4 FEA and physical testing model

In automotive industries, it's the industry standard of optimizing structural design to use FEA to do computational prediction. Naga is going to build an accurate FE model to predict the roof crush strength and the timing of structure intrusion. Based on FMVSS216 testing conditions, correlate the peak roof crush strength as well as body stiffness and the peak intrusion strength output from FEA with physical test to determine the best combination of physical and computational parameters (Narayana, 2011).

Not only in industries, like in MEMS and medical's research, FEA also plays an important role. According to FDA-testing requirements, it will cost \$1.2 million of the company to finish entire line tests. To solve the finance problem, company has to use FEA tools to pass testing (Mraz, 2009). In order to research influence additional drilled suction holes on femur strength and fatigue life, Melanie takes use of the FE model. Complete model is generated based on the FEA results output from ABAQUS and Hyper works software package and physical test results

output from Instron 4505 universal testing machine. In addition, physical test results also play a role of validation (Foxl, 2013).

Obviously, FEA is widely accepted because of its advantages. Analysing company's work mentioned above, its merits are shown in Table 3-1.

Table 3-1 FEA's merits

Researcher	Merit
Faith	Reduce prototype and cost
Tiago	Reduce prototype and cost
Wen	Low cost and time saving
Bayani	Low cost and time saving
Costello	Display the complex failure mechanisms
Narayana	Product prediction
Foxl	Reduce cost

The main advantage of the FEA is that it produces a much more detailed results than physical testing investigations, also always quicker and lower cost. Fundamentally, it benefits from its mechanisms, subdividing a big problem into smaller and more easy solvable problems are much more efficient than solving it directly (The product research & engineering company, 2020). What's more, FEA can provide more performance insight and more detailed information about design's performance. The advantages of FEA being widely accepted are as follows (Newswire, 2006) (Helmut Dannbauer, 2006) (Wilde, 2020) (ASR, 2020):

- Analysis complicated loading layouts, environments and designs.
- Access to more performance information to improve design layouts.
- Reduce the number of prototype and time.
- Cheaper than expensive physical testing.
- Obtain a better understanding of a design's performance.
- Solve non-linear analysis problems.

In chassis' lightweight work, FEA is used to test whether the torsional stiffness of different lightweight model meet the industry standards. If using physical testing to realize the lightweight design process, too much prototype and time are needed, or it's impossible to finish the work at low cost and time personally.

4 Correlation

It's important to build a good correlation between FEA and physical testing. If the FE results are correlate well with the physical testing results, the FE model will be very powerful. Hence, it's feasible to change the model parameters to obtain an optimal design for the product. Up to now, comparing the FE results with results got from physical testing is the best way to verify and validate the FE model (Donald). And in the modelling process, all physical variables should be taken into consideration, or the simulation results disconnect with the physical testing results. Correlating the model is an important part in the process of build the FE model. Generally, 10 to 15% difference in FEA and experimental results is considered a good correlation (Lake, 2020). All in all, physical testing results are beneficial to simulation improvement and giving feedback to decrease the distance between the real and virtual world (Tiago Sartor, 2015). Conditions and parameters in FE model will be improved in terms of the difference between these two, it's also the process of building the correlation.

According to company's work, many researchers use physical testing results to verify the FE model, and suitable adjustments are put on the model to make the model more accurate. Then, the model can be put into further design work or in the industry as a standard to develop it advantages. Absolutely, the correlation is the basis that makes the FEA's work reliable. Of course, it's also important in author's lightweight work.

In author's work, the optimization direction of the chassis is using different material. Therefore, some steel bars in the original model will be replaced with aluminium bars. In addition, all the lightweight design and analysis process are carried out in the FEA. Most importantly, it needs to be confirmed that the original model used for lightweight must be precise enough, or the further work is useless. In other words, there need to be a strong correlation between the CAD model and the real chassis. The method accepted to test the correlation is the torsional stiffness. Torque of same value is put on both CAD and real chassis, shown in Figure 4-1. Then the torsional stiffness of different positions can be calculated based on the displacements, results shown in Figure 4-2.

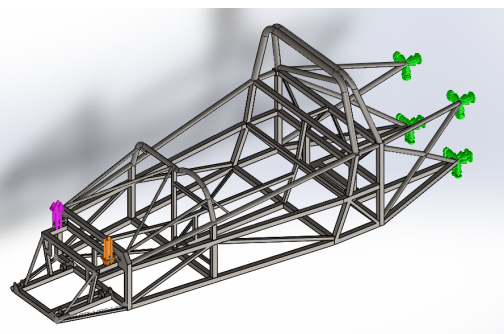


Figure 4-1 Physical (left) and FEA testing (right) (SolidWorks2019)

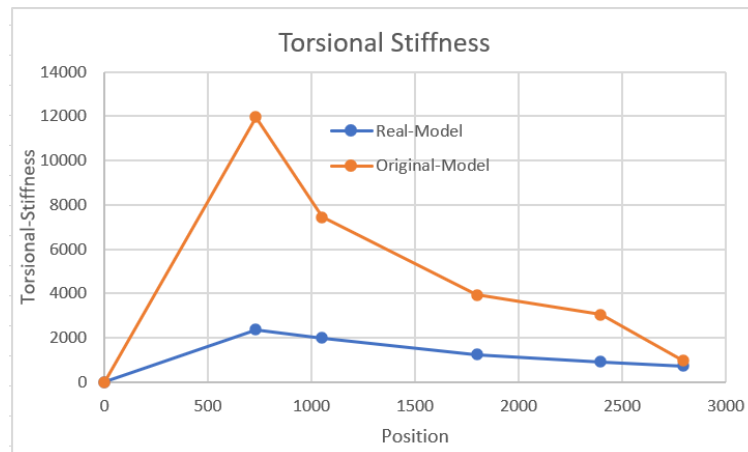


Figure 4-2 Torsional stiffness of real and CAD model (EXCEL2016)

From the curves, there is a big difference between the physical testing and FEA results. In other words, the correlation between these two is not enough. Hence, there must be something wrong in the FE model. After analysing the FE model, some details are not shown in the FE model. In the physical testing, some bars are connected on the front and rear part to apply the load and fix the chassis, not drew in FE model. The influence carried by those bars maybe impact the results, the displacements on the bar or other connectors should be taken into consideration. Hence, the FE model is optimized shown in Figure 4-3.

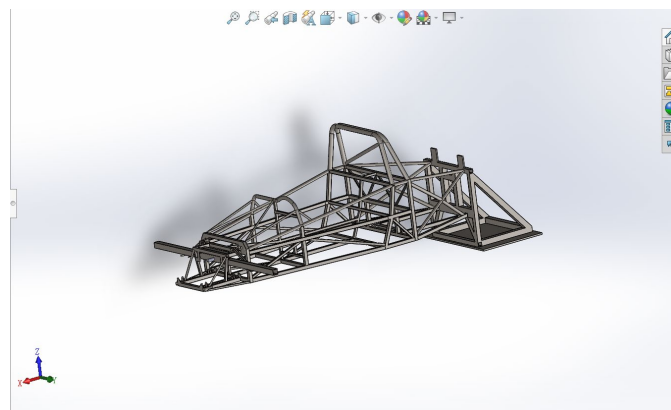


Figure 4-3 Optimal Model (SolidWorks2019)

All in all, the best way to build the correlation is comparing the physical testing and FEA results. In terms of the difference, analyse whether the parameters and conditions in the FE model is correct or not, then optimize the model. What's more, the physical testing results can give FEA some reference about the material or the mechanisms. If there is no correlation, it makes no sense to do the FEA work.

5 Discussion

Many companies make FEA as a tool to end physical testing forever, also many customers expectation when using FEA to analyse. Though FEA does reduce the need for physical testing, it absolutely has not eliminated the need for physical testing (Donald). In author's opinion, FEA can't replace the physical testing forever.

Firstly, physical testing is the basis of the FEA. Dr. Parnell, an expert in the development and application of FEA techniques and the use of computational analysis to solve real-world problems, thinks that FEA can't totally replace the physical testing. FEA is not enough, physical testing is need to understand the variability in geometry, load, conditions and loads (Wong, 2010). There are many material parameters, models and formulas got from physical testing in professional software like Solidowrks, Adams etc. Though the software can solve several present issues, the information needs to be updated. Technologies will become more advanced, environments will become more complex, new material and new approaches to problems will appears, the simulation software need to keep in line with the forefront of the industry to satisfy customers' demands. Therefore, the physical testing is forever needed.

In addition, it's necessary to verify and validate the FEA results by physical testing results. In FEA software, the working condition and some details can't be fully restored, because there is more randomness in real production but the software is well-regulated. Therefore, the FEA results also can't restore the physical testing results. If the difference between FEA model and testing is too big, the further analysis is meaningless and unfounded. For example, if physical testing is not carried out on the chassis, the lightweight work will be based on a wrong model. And the chassis produced in terms of its optimization layout must can't satisfy the races' standards. As mentioned before, 10 to 15% difference in FEA and experimental results is considered a good correlation. Physical testing is the tool to achieve this goal.

What's more, more high-value of the product comes more requirements about life and safety. Therefore, there is more work to do besides basic FEA. (Wong, 2010). As an extreme sport, the safety is also a crucial parameter of the race car. If the chassis's lightweight work only finished in software, it must be an unqualified product. What if one plane or one car is just designed in FEA software, maybe no one dares to be on it. Therefore, physical testing is the guarantee of product safety.

6 Conclusion

Finite element analysis is becoming a common tool of product design and optimization. With the development of industries, FEA takes up more and more percentage than physical testing in product development. However, FEA is always carried out alongside the physical testing. The topic of this report is the role FEA played in product development. More subdivided, this topic is explored in three aspects: why company's FE work is always carried out with physical testing, how the correlation between FE model and physical testing is built, whether physical testing can be replaced by FEA forever. What's more, a case is accepted to provide example for the whole analysis. The target of the case is doing the lightweight work on a race car chassis by FEA. Before optimizing the chassis, it is necessary to do FEA and physical testing on the virtual and real model to guarantee the validation.

Companies in several industries, including agricultural tractors, automotive, medical and MEMS, take use of FEA alongside physical testing in production because of FEA's practical advantages. Comparing with traditional experiments, FEA can reduce the cost, time, number of prototypes and improve the quality in some way.

Correlation between FE model and physical testing is the basis of the research work. Physical testing results are always used to verify the FEA results, and provide some material variables, experimental data, based on which FE model is perfected. The correlation is built through this process.

Though FEA plays a very important role in industries, it can't replace the physical testing forever. Physical testing can provide basic but important information to FEA software. In addition, FE model must be fixed and verified by the physical testing. The Physical testing can also guarantee the safety of some products.

7 Reference

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