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Career Episode 1

Introduction:

CE 1.1:

In this career episode, I am going to explain my bachelor's project. The project was entitled to "Design and Finite Element Analysis of Belleville Spring." I started working on this project when I was in the final year of my bachelor's degree. During the project, I was studied in the mechanical engineering department at the Jawaharlal Nehru Technological University. The project tenure from …… to …….

Background:

CE 1.2:

The Jawaharlal Nehru Technological University was established in 2nd October 1972 and located at Hyderabad. The university is accredited by NAAC (National Assessment and Accreditation Council),and it also gained "A" grade for the NAAC. It is affiliated with UGC, NAAC,and AIU. The objective of this university is the Gateway to Excellence.

CE 1.3:

The main scope of this project was the analysis ofdeflection and stress produced in a Belleville Spring. The method used to accomplish this analysis was the finite element method. This project shows the work deals with static Analysis of Belleville spring along with Modal analysis in order to find natural frequencies and Transient analysis is done to obtain dynamic results.I considered a combination of multiple ratios including the parameters such as inner diameter, outer diameter, height, thickness, etc to calculate the principle stresses of the inner and outer surfaces including the deflections.

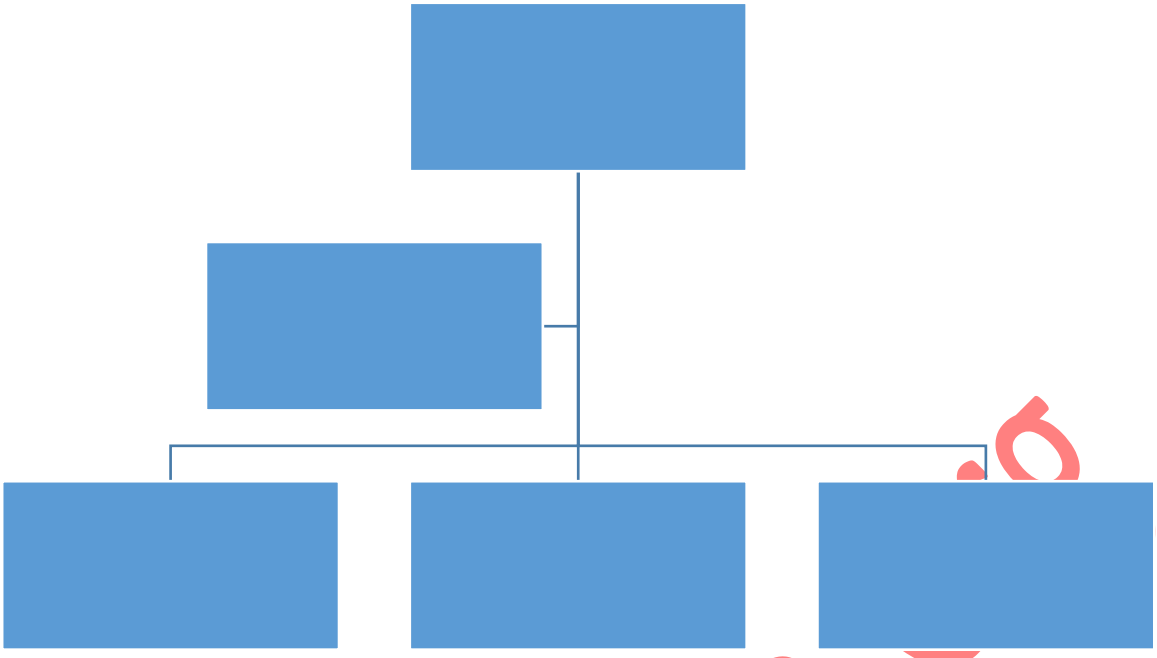
CE 1.4:

I performed the following duties during the tenure of the project

- Prepared the methodology of the project
- Arranged the meetings with my supervisor and discussedthe project detail
- Analysed the project activities and reported them to the supervisor
- Scheduled the daily project activities and assigned them to the team members
- Selected the appropriate materials for the project
- Tested some biomedical applications and prototypes in certain environments where the conditions were undesirable
- Optimized a design to reduce the production cost at the development stage

CE 1.5:

This hierarchy explained my position during the project:



Personal Engineering Activities:

CE 1.6:

To enhance my knowledge regarding my final year project I conducted aliterature review on my topic and read several research papers. I also visited the central library to get the information regarding the project details,and I read the books like Finite element analysis for engineers by Carl HanserVerlag. I also arranged weekly meetings with my supervisor and team members to discuss the project layout and procedure. I made the documents of the project and planned the activities accordingly. I visited the CAD lab in the P.V.P Siddhartha Institute of Technology. I also gave presentations to the supervisor about the project details.To design computer models or transmit CAD models of different products, I used analysis software called ANSYS finite element analysis. Using this software, I could apply operating loads, study physical responses, identify the impact of electromagnetic fields, determine stress level and temperature distribution, and design performance conditions.

CE 1.7:

First of all, I analyzed the Belleville spring under the static axial compressive load of 1000N. I used different geometrical analysis parameters of a Belleville spring which were t, d, h, and D to identify the number of deflections and stresses that occurred in the Belleville spring. I considered following ratios for the analysis like D/d= 1.2, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5 and h/t= 1.25, 1.5, 1.75, 2, 2.25, 2.5, 2.75,3. Using the ratio D/d and h/t, I determined the stresses and deflections caused by the spring on the inner and outer surfaces. I considered the outer diameter of Belleville Spring which was 125mm; inner diameter was 31.25 m, thethickness was 3.33 mm and height of Belleville Spring was considered 5mm. On the inner surface of the spring, I applied a 1000 N force in Y-direction. Then, I analyzed the deflection in X and Z directions by imposing boundary conditions. I used FEA software to create the element mesh, to analyze the defined problem, and to review the results of the analysis. During the mesh production, I considered that the mesh should have a well-shaped elements only mild distortion and moderate aspect ratios. I used my engineering skills to calculate the data from the FEA. I performed following calculations:

Simple Two Spring Model (1D).

F=K*x means

F1 = (K1+K2)-K2 U1

F2 = -K2+K1 U2

Applied Force=Internal force in the springs leads to a [K] matrix with both spring constants.

CE 1.8:

I used solid modelingmethods for the model generator. I used the solid modelling technique to describe the geometric boundaries of the proposed model and establish desired properties of the elements like size and shape. The nodes and components were automatically generated using the ANSYS software. While generating these elements, I controlled the size and number of generated elements simultaneously via ANSYS software. Using element characteristics, I also checked the automated generation capability of the pre-processor to verify the connectivity, distortion index, etc. Instead of defining individual nodes, I used the automated mesh generation ability of the pre-processor. I observed that Pre-processor automatically generates nodes on each meshed geometric entity. This leads to coincident nodes,i.e., two or more nodes within the certain tolerance at the common edge or faces of entities.I sequenced the mode numbers in the pre-processor, node numbers according to the user-defined starting number.

CE 1.9:

After the completion of thefinite model, I applied the loads to the models and chose multiple ways to define the loads and constraints. I assigned all the constraints and loads at 1D because this helped to keep track of all the load cases. In the model phase, I viewed this from different angles. I viewed the model from multiple angles by rotating it using the global system. For this purpose, I enlarged the targeted area of the model via pre-processor for more visibility and better details. Then, I conducted a static analysis and inspected the stresses, displacements, strains, and forces in the system caused by the loads with insignificant weight and damping effects. I performed Static analysis in three steps. I started off by building a model and mentioned the analysis title and job name. To define the properties of the elements like types, real constants, geometry, etc, I utilized PREP7 which involved both types of elements, linear and non-linear. I used Young modulus (E) for the static analysis of 2.1*10^5. The second step was to obtain the solution. In this step, I copied the finite element solution to define the type of analysis, explore options, and manage loads. The results of this step were reviewed later on. For layering the applications, I used SHELL 208 element description. It helped me to laminate or sandwich the shells.

CE 1.10:

For SHELL208, I specified node locations, coordinate system for the elements, and geometry of the elements. In the geometry, the elements were specified in two nodes. To determine mode shapes and natural frequencies of the model, I performed a model analysis. For this purpose, I used a pre-stressed body like a spinning turbine blade or a hollow cylinder, etc. I reviewed a single sector of these symmetric structures using modal cyclic symmetry. Later on, I performed a transient dynamic analysis to check the dynamic response of the proposed structure with respect to a time-varying load.

CE 1.11:

During the project I faced complex situation with the stacking of the Multiple Belleville washers for modifying the constant spring or the deflection rate. Initially, I decided for different Stacking options and analysed the results. As per my analysis if we add the spring parallel it will be

resulted in a stiffer joint (having same value of deflection) and if we add the spring in series mean in alternative direction will be resulted in lowering the constant spring constant and more deflection. I conducted analysis; If n is the spring number in a stack, then: (i) Parallel Stack (n in parallel, 1 in series) - Deflection is equal to that of one spring; Load is equal to that of n x 1 spring. (ii) Series Stack (1 in parallel, n in series) - Deflection is equal to n x 1 spring; load is equal to that of one spring.Consequently, depending upon the application, the stacking can be:

- Parallel resulted inhigh load
- Series stack resulted in high deflection
- The deflection and load was adjusted by the removal and addition of individual washers either parallel or in series

As per the analysis, I found that the while in parallel stack, occurance of the load losses was because of the frinction in the springs. Using the hystresis method, I calculated the loss due to friction. I suggested not to place more than 4 springs in parallel. I also proposed to increase the safety factor if ahigh load is needed, for compensating the frictional loss. Friction loss is not as much of an issue in series stacks. I also found that the in a series stack, the rate of the deflection was not proportional to the spring number. This happened due to the bottoming out effect on the compressing of the spring. To meet with this challenging issue, I suggested icreasing the contact area increased once the spring was deflected beyond 95%. This resulted in the moment arm decrease and good amount of spring resistanve was offered by the spring. I used the hysteresis for predicting the deflections while in series stack.

CE 1.12:

During all these activities, I followed the ASTME Engineering Standard and exhibited my understanding with these engineering accountabilities. I upgraded and revised my engineering knowledge through libraries and seminars. I attended many seminars related to welding conducted by the welding companies. I often visited National Library to read research journals and related research material. I also borrowed many books on engineering disciplines subjects and made notes comprised of important technical points.

CE 1.13

I worked in collaboration with all the team members. I understood team issues and tried to resolve them with effective leadership skills. I organized team meetings and discussed with them issues that they have faced during the project. I gave everyone to speak out there opinions. I gave importance to their opinion this helped them to work more efficiently. I regulate and supervised their activities. I maintained highest integrity level. I coordinated with them at each phase of the project. I planned the activities and prepared the work break down structure. I also collaborated with the seniors and expert persons in this field to take their opinion and guidance on various issues.

CE 1.14

Being well versed with different computing software, in this project I used the CAD software for developing the model. I also worked on Ansys for analysis. Apart from this MS word and PowerPoint was used for preparing the project report and presentation

Summary

CE 1.15

The project was completed as per planned. I contributed to the success of the project through utilizing my engineering knowledge. I made many calculations which were directly needed for the design. I conducted standards researches and implemented the solutions to the issues. I have

gained lots of engineering experiences. I felt happy in completing this report as it gave me a vast analysis experience.

Career Episode 2

Introduction:

CE 2.1:

This career episode illustrates my project on "Stress Analysis of a composite plate with an elliptical hole." I started this project in my final year of bachelor's degree under the guidance of my supervisor. I was elected as a group leader in the group of 4 members. During the project tenure, I was completing my degree on bachelors of technology in mechanical engineering at P.V.P. Siddhartha Technology. The project was initiated at …… Month/Year and finished at …….Month/Year.

Background:

CE 2.2:

P.V.P. Siddhartha Technology established in 1998, situated at Andhra Pradesh. In 2008 the university was certified as ISO 9001 due to its quality standards. It is accredited by NBA, NAAC, and AICTE. The department of mechanical engineering in the institute has a versatile, qualified and talented faculty members and they graduated capable mechanical engineers after every four years who have a numerous knowledge of their field, and they can easily solve every critical problem. This department also organizes workshops for the engineers to promote active industry institute.

CE 2.3:

The main focus of the project was on the analysis of stress-strain and for the uniaxial load on the composite laminates. Three different orientations of fibers are analyzed with elliptical cut-outs. Also, different dimensions of elliptical cut-outs are applied to the laminates. The finite element software ANSYS has been successfully executed for the project.

CE 2.4:

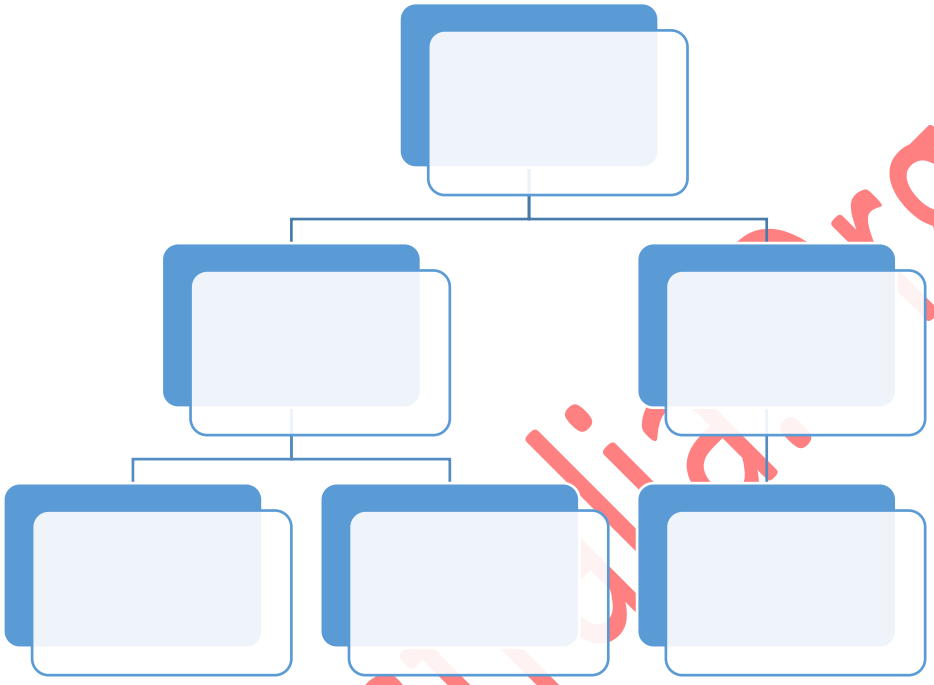
As a group leader I accomplished following duties:

- Arranged several meetings with the supervisor and the team members to discuss the project methodology, procedure, and design.
- Analysed the results of the analysis test and reported them immediately to the supervisor and change the procedure if needed.
- Handled materials during the project.
- Performed the daily tasks and supervised the work of other members.

- Developed the schedule of project activities.
- Approved my test results from the supervisor before starting the project.
- Managed the work done by other members and finished the project at the given time.

CE 2.5:

This hierarchy demonstrates my position in this project:



Personal Engineering Activities:

CE 2.6:

Before initiative this project, I arranged several daily meetings with my supervisor to discuss the project methodology and process to be followed. I conducted literature review on my topic by studying various research papers like Lekhnitskii.S.G, "Anisotropic plates", Gordon and Breach, New York, 1968, MSR Niranjan Kumar, M.M.M. Sarcar, V. Bala Krishna Murthy, "Analysis of thick skew laminate with elliptical cutout subjected to non-linear temperature distribution Major axis of ellipse vertical". International Journal of Theoretical and Applied Mechanics Year: 2008, Volume: 3, Issue: 1, pages 37-43 and also studied various books on it. I also took help and suggestions from my professor and seniors. They also provided me a lot of facilities in the department. Finally, I gave presentations to the supervisor and the head of the department for the approval of my project analysis methodology, and after this, I assigned the duties to the team members and initiated this project under the inspiration of supervisor who helped me a lot during the course of my research work.

CE 2.7:

I did the static analysis of the composite plate with an elliptical cut-out to evaluate the stresses in the clamped laminates which are subjected to transverse pressure load. After this, I arranged the material in the individual layers by doing the five analysis like I performed the stress analysis on a metal plate with the elliptical hole. Then I did the stress analysis on a composite plate with uniform thickness for both cross-ply and angle-ply laminates {(0/90/90/0) and (0/45/-45/0, 0/30/-30/0)}. After that, I did stress analysis on a composite plate with varying thickness, i.e., taking higher thickness in the middle two plates. Afterwards, I did Stress analysis on a composite plate with varying thickness, i.e., taking higher thickness at the top and bottom plates. In the end, I varied the ratio a/b of the ellipse. I used ANSYS software for the evaluation of the all the five analysis case of stresses in the laminates. I varied the a/b ratio of the ellipse to obtain the evaluation of the stresses. I draw graphs for all the stresses analysis and the 1/t ratio.

CE 2.8:

I prepared a geometric model for this I considered a square plate with an elliptical hole which was subjected to the uniform stress. I calculated the thickness of plate which was t = 3cm. The material I selected for the plate was Young's modulus $E=2*10^7$ N/cm^2 and Poisson's ratio $\nu=0.3$. I also calculated the length and width of the model which was 30 cms. I selected solid layered 191 for element behavior. I defined the one real constant for thickness and one set of material modeling,and I employed the solid modeling approach. Due to the bi-axial symmetry of the geometry and loading, I considered only one part of the plate for the analysis. After this, I used ANSYS software to do the modeling of the composite plates the finite element mesh as per the geometric modeling. The material properties of the geometric model, I used for the FRP hybrid material are the elastic modulus, the poison's ratio, and the shear modulus. I took these material properties, and I used composite materials for the geometric modeling. The composite I selected was epoxyt300. After this, I did the boundary conditions and loading. In boundary conditions and loading, I made all the sides of the plate clamped. Then, I subjected the transverse pressure load of 2MPa on the composite laminate.

CE 2.9:

I performed all the finite element analysis on the ANSYS software by using this I obtained the stresses. I took the result in both Cross-ply and Angle-ply laminates. After this, I considered the effect of skew angle and the effect of thickness of the plate in the two cases: Four-layered Cross-ply laminates and Four-layered Angle-ply laminates. I observed that in the Cross-ply laminate the fiber angle between the adjacent layers was 90^0. I considered the effect of a/b ratio of the elliptical cut-out for evaluating the stresses and deflections in the laminates.

CE 2.10:

I made the elliptical out-cut on the plates at the geometric center of the plate. After this I applied the pressure of -2MPa is applied to the plates by taking the boundary conditions as clamped. I noticed that in both Cross-ply and Angle-ply laminates, the values of stresses and deflection decrease with increase in the thickness of the composite plate. For a constant thickness value, I had varied the a/b ratio of ellipse ranging from 0.5 to 1.5. This may be due to the decrease in resultant force acting on the plate due to increase in the geometry of the cutout.

CE 2.11:

So, I concluded the following details from the analysis results like, I observed that the thickness effect of the layer of the composite material and stress distributions along the layers, I also observed that for the metal plate the nominal stress along the x-direction remains constant, slightly varies along y-direction but in z-direction as the l/t ratio increases stress value decreases, I noticed that for the composite plate the variation w.r.t to (0/90/90/0) orientation the effect is very low when the thickness remains same for all the layers and when the thickness of the layers varied the there is a slight variation in (0/45/-45/0) due to higher inter laminar shear strength. Throughout the project I followed the ASTME standards.

CE 2.12:

During the project, I used personal protective equipment's and assured that they are according to the OSHA rules. I make assured that my project activities did not harm the environment and also did not cause any hazardous effect. I also arranged health and safety training in the mechanical department in collaboration with the universities societies to aware my other team members with the rules and regulations of the health and safety. I made the environment healthy and also took first aid box with me in the case of any minor injury. I also created a plan to control hazards in the workplace and talked regularly with my members about the safety.

CE 2.13:

I kept my team members united during the projects and performed every task by taking help of each other. I coordinated with them at every step, and we work as a team. I arranged the meetings between supervisor and team members in this we discuss the future problem regarding the project and by brainstorming we resolved these issues. I gave every member the equal opportunity to raise the questions in the meetings, and I appreciated their every question.

CE 2.14:

I witnessed myself grow as a human being and as an engineer during the project duration. I displayed remarkable leadership skills throughout the tenure and tried my best to keep my team strong. I did not just manage the team, but I also managed the expenses of this project and the time in which the project needed to be complete. I used budget-friendly approach to prevent my

university from bearing excessive loss. I tested all the materials first and then implemented them in the system.

CE 2.15:

During my time as a student, I studied courses regarding Technical Report Writing and Functional English which proved helpful in this project as I was able to write detailed report fluently. Starting from the project proposal to funding request and final report, I had prepared a number of reports which improved my typing speed immensely. I was able to convey myself better during presentations and meetings. All the documenting process were my responsibility, so I was able to practice more.

CE 2.16:

I requested the technical societies of Mechanical Engineering Department to arrange informative seminars and workshops, and I'm very thankful to them that they paid heed to my request as I got a lot of useful knowledge regarding the machinery used in this project. I was able to understand the purpose of all the tools and equipment. One-day seminars were quite helpful in providing guidance for handling heavy machinery as they were short and to the point. I got a better command over all these tools due to these seminars.

Summary:

CE 2.17:

I completed the project on time, and I would like to thanks all the members who aided directly or indirectly for successful completion of this project work. The project completion was indeed a tough job, I faced a lot of difficulties, but it was completed successfully under the supervision of my supervisor. It enhanced my ability to work under pressure and the ability of work well within the team. I get appreciation from my supervisor, head of department and team members. This project also enhanced my organization skills like time and resource planning.

Career Episode 3

❖ **Introduction**

CE 3.1

This career episode encircles the details of my project on IMPROVING THE QUALITY OF WET CYLINDER LINERS that I executed while I was a B.Tech Mechanical Engineering student. The facility in which I carried out the works of this project was KUSALAVA INTERNATIONAL LIMITED and the total duration of this project was from _____ to_____

❖ **Background**

CE 3.2

This document provides an overview of current Indian Industry Scenario. The country is a central hub for Automotive Spare parts. One such leading Industry in Automotive Spare parts is KUSALAVA International Ltd. Cylinder Liner forms an important component of Automotive Engines. Raw material yard collects ferrous materials from scrap. Basic structure and operation of Medium Frequency Induction Furnace are thoroughly discussed in this report, which was employed in obtaining the Molten Alloy for Cylinder Liners.

CE 3.3

Cylinder liner is used in the engine block to give a wear protective sliding surface for the piston and to achieve these properties high-quality liners must be produced. However, various elements in the machining process such as machining sequence, plant layout, jigs and fixtures and various factors related to man, machine, method, material, and environment affect the quality of cylinder liners. So the purpose of this project was to find suitable solutions for producing an optimum quality liner that can withstand the stated.

CE 3.4

Hence, in this project, by analyzing and identifying the current defects experienced in the production process and deriving solutions for the problems identified, the problem can be reduced. The scope of the project also included changing the machining sequence and finding the suitable sequence of operations and also detecting the causes of various major defects and controlling the errors. Finally, the problem was resolved, and the whole process was analyzed,and the optimum machining sequence was implemented which was 8% of increment in the production of grade one-liners and various other errors and its solutions due to the stated factors were found. 4% increment in the production of grade 1 liners was shown which meant that a total percentage of grade 1 liners was increased from 84% to 96% which was the optimum product quality obtained.

CE 3.5

My roles and responsibilities throughout this project were;

- Arranged formal meetings with the team and technical engineer to devise the project plan
- Coordinated with the team to communicate the details of the project in a better way
- Documented project procedures right from the beginning and finalized a proper report in the end

- Prepared project drawings, flowcharts, and cause and effect diagrams
- Performed calculations and analyzed the results
- Complied with the standards of the company to achieve the tasks

CE 3.6

My designation is clearly represented in the hierarchy below;

❖ **Personal Engineering Activities**

CE 3.7

I started this project by thoroughly studying the production contents of the project and devised a flow chart that represented the production process in the foundry for better understanding. Next, I learned about the raw materials used for charging to know about the properties of each material. All the raw materials required for production were handled by the general stores and supplied to various sections depending on the requirement. The involved raw material was sent for their quality checking by the material supervisor and then accepted. I learned that the raw materials used for charging included; home scrap, pig iron, steel or sponge iron, and Ferroalloys.

CE 3.8

I also got more insight into the working of a furnace. Melting was the major factor which controlled the quality of the casting. I studied a number of methods available for melting foundry alloys, such as pit furnace, open hearth furnace, rotary furnace, cupola furnace, induction furnace, etc. The choice of furnace depended on the amount and the type of alloy being melted. After charging of raw material and other alloying additions, the furnace was in the melting stage. In melting stage, the slag was not taken out up to some time because it minimized the heat losses during melting due to contact with atmospheric conditions. In this project, I was taught the analysis of elements present in the metal before manufacturing of cylinder liners. The percentage of elements present in the liquid metal was found out by using the spectrometer. An inoculation was a material added to the liquid metal just before casting which provided suitable sites for the nucleation of graphite.

CE 3.9

Metallography was performed for preparing specimens for microscopic examination of metals and alloys and interpretation of microstructure. The metallurgical microscope was used to know the structure of the sample. I also visited the mechanical maintenance department of the firm

which was also one of the sections in the KL-1 foundry. Types of mechanical works like the reaction of the F/C, preparing of the slag spoons, making transportation of trolleys and other auxiliary works like proper maintenance of the F/C, lifting system, Bull ladle monorail maintenance, etc. were the main functions of this section. Other main things were the die maintenance, preparation of the dressing pipes, gausses, and fabrication works are also included in this department. I also visited the powder room which was one of the main sections in the Kusalava international ltd. It helped in the production of defect-less casting in the foundry. Machine division was another main section next to foundry. The most vital role of manufacturing was carried out in the production department. Witnessing the processes in these departments helped me to learn the characteristics of the material and use the measuring tools and equipment in a proper way.

CE 3.10

I designed the operational sequence of the project model. The first step of this sequence was rough boring. In this operation, there were two types of machines, i.e., SPM & TICO, which I learned to use. The next step that I performed was the rough CNC turning. Computer Numerical Control Turret Lathe was used for machining in this operation. In the fine boring operation, a vertical axis three jaw chucks held the liner rotating at high speeds. A vertical boring bar which acted as a boring bar cut the inner profile, and in this operation, the final dimension inner diameter came. Boring was used to achieve greater accuracy of the diameter of a hole and was used to cut a tapered hole. I executed the boring process using various machine tools, including General-purpose or universal machines, such as lathes or milling machines.

CE 3.11

I performed the rough honing operation in which a honing machine with vertical axis spindle having a cartridge held the honing sticks. The tool holder and job holders were same as rough CNC turning but the material machined was very low for achieving the high surface finish. In this operation, I finalized all the outer dimensions by performing operations like Turning, Facing, Chamfering, Grooving, Threading, and many other required operations were performed on the cylinder liner in order to obtain the complete finalization of all the parameters on the outer diameter. In the final honing operation, the tool holders and job holders used were same, but the honing sticks used for honing were high graded. In this operation, I formed the cross-hatching. After all the operations were performed, phosphating was done, and at every operation, coolant was used.

CE 3.12

I performed quality control operations with the control department which had a significant role in the production of the good quality system. Quality control was the section in which I inspected the defects and passed over to the other sections. I viewed the inspection into three stages; Online analysis, Quality Control Room Inspection. I performed Visual Inspection, Total Length Inspection, Inner Diameter Inspection, Collar Width Inspection, and Final Parameters Inspection.

CE 3.13

I initiated the plan of action. To improve the quality of the wet cylinders being produced initially the current operations and its sequence were studied and observations regarding the dimensions of the liner at each stage and the various effects of man, machine, method, material, and environment were collected. The collected data was analyzed, and the areas that affect the production were marked. I devised the marked problems with suitable solutions, and the solutions were implemented in the system. Once the new methods were taken into action, a new trial was conducted, and a new set of observations were made, and the cycle was followed till optimum results were achieved. After conducting trails and find the most suitable machining sequence, various other causes related to man, machine, method, and material contributing to the decrease in product quality were analyzed, and required actions are taken.

CE 3.14

I performed a series of trails to find the problems. In the first trial, a batch of fifty liners were passed through the process flow, and each liner was followed through every stage and observations of its dimensions at each stage were recorded in the line and finally every liner was again rechecked at the quality inspection room, and all the data was kept for analyzing and detecting the effective areas. The observations of the process were made in the month of January. I observed that the current operating procedure was managed and 85.12% of grade one-liners and 14.08% of grade two liners and where the company had to manufacture about 94% or above grade 1 liners and the remaining percentage of grade 2 liners. The top 3 reasons for sorting the liner as grade 2 liner were; ID Ovality, SD Ovality, and Damages. To find the operations at which the bottleneck defects were formed, I recorded the readings at each major operation. From readings at each operation, I observed that ID ovality was being formed at rough honing and shoulder diameter ovality was being formed at grinding procedure.

CE 3.15

My findings suggested that the ID ovality and the shoulder diameter ovality were highlighted at its final stage grinding and rough honing. To reduce the id ovality formed at the time of boring

and rough honing, I introduced a new procedure, i.e., tapping where the liners detected with id ovality were tapped on a fiber stand to eliminate ID ovality. On the other hand, due to tapping of the liner there were changes in the outer diameter where ovality was formed on the outer diameter, and this was minimised by changing the sequence of operation by shifting the grinding to the last position such that any OD ovality obtained during tapping was eliminated in the grinding process by OD machining.

CE 3.16

By changing the machining sequence and introducing the tapping procedure, I conducted a second trial on the new setup. The observations were taken from the last 3 operations of rough honing, fine honing, and grinding to observe if any change was obtained from the new setup. I observed that there is an increase in grade 1 liners from 84% to 90% percentage for further testing a third trail is conducted by bringing the grinding operation before final honing and placing final honing as the last operation. In the third trail, the final honing process was placed as the last operation, and grinding was placed before final honing. I observed that there was an increase in grade 1 liners from 90% to 92% percent which showed a slight deviation so keeping machining sequence further reasons were contributing to the defects in the production were analyzed.

CE 3.17

In the final trial, the machining sequence was kept unchanged, and various other factors affecting the quality of production which is related to man, machine, material, method, and environment were analyzed and solved to further increase the quality of the liners. I noted the observations and analyzed through cause and effect diagrams, and the observations that were the causes of the major defects were; inner diameter oversize, inner diameter ovality, and collar width variation.

CE 3.18

Through the cause and effect diagram, I began solving the problems. To solve the probable cause of inner diameter oversize, I changing the manual unit to auto unit, hardened fixtures to be provided at both rough and final honing, checked the centering and performed air balancing. To resolve inner diameter ovality, I provided a manual lock for clamping and honing the machines, provided the lock at Nagel 2088 P7-2, loaded CNC tooling software with a buzzer, hardened fixtures to increase life, and changed the process to 2D. I resolved the collar width variation problem by reducing the tolerance for collar width at 2DR, providing CW fixture setup for 0.100 mm tolerance, providing program lock, providing undercut formation,

implementing tool life program, defining fixture calibration frequency and compared CW in a shift.

CE 3.19

I was an energetic participant of the project team and used my proficient communication skills during the project meetings and presentation. I encouraged the participation of other team members during the meetings and kept interacting well with everyone. My major tactic to capture everyone's attention was to ask a question during the meeting and while giving presentations. The outcome of each meeting was recorded in for of a report which was approved by the department and company's head.

CE 3.20

During the project, I was actively involved in control and supervision processes. I communicated the tasks and duties of each team member very effectively which ensured the smooth flow of project activities. Ultimately, we were able to complete the project within proposed time, using available resources.

CE 3.21

Safety procedures were prioritized during the project, and I made sure that everyone followed the safety tips while carrying out their respective tasks. The company provided us with safety training and acquainted us well with the machinery for proper usage. I made sure that the scrap material was discarded in a safe manner.

❖ **Summary**

CE 3.22

I feel happy with the on time achievement of the project goals. I received the appreciation for working hard on this project. I coordinated at each phase of the project with my team members. Great help of my Supervisor lead me toward my technical improvement. I continued with my learning through research and technically became sounder. I prepared well-structured reports that showed my writing skills.

PROFESSIONAL ENGINEER

Summary Statement

Competency Element	A brief summary of how you have applied the element	Paragraph in the career episode(s) where the element is addressed

PE1 KNOWLEDGE AND SKILL BASE		
PE1.1 Comprehensive, theory-based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	I completed the technical activities of the project by using my engineering abilities. I also resolved the complex issues	CE 1.8, CE 1.9, CE 1.10, CE 1.11, CE 2.7, CE 2.8, CE 2.9, CE 2.11, CE 2.12, CE 3.8, CE 3.10, CE 3.11, CE 3.13, CE 3.14, CE 3.15, CE 3.16, CE 3.18
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics and computer and information sciences which underpin the engineering discipline	I successfully utilized diverse expert programming software in order to carry out different calculations and technical activities Completed mathematical calculations as the outline prerequisites which demonstrated my numerical comprehension	CE 1.6, CE 1.7, CE 1.14, CE 2.7, CE 2.8, CE 2.9, CE 3.18 CE 1.7, CE 1.9, CE 1.11, CE 2.7, CE 2.8, CE 3.11
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	I performed ANSYS finite element analysis. I used the FEA analysis software and CAD designing software to achieved my designing processes	CE 1.6, CE 1.7, CE 1.14, CE 2.7, CE 2.8, CE 2.9, CE 3.18
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	I recognized new developments in my engineering field, through research and studies and implemented the new techniques in my mission for effective outcomes	CE 1.6, CE 1.12, CE 2.6, CE 2.16, CE 3.7, CE 3.8
PE1.5 Knowledge of contextual factors impacting the engineering discipline	Facilitated with my team members, discover their abilities and consequently assign them obligations. I arranged the undertaking plan	CE 1.10, CE 1.13, CE 2.12, CE 2.13, CE 2.14, CE 3.12, CE 3.19, CE 3.20

	and organized activities accordingly.	CE 1.7, CE 1.9, CE 1.10, CE 1.13, CE 2.7, CE 2.14, CE 3.9, CE 3.19
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the specific discipline	Efficiently conveyed out the deign plan procedure furthermore applied the engineering principles	CE 1.8, CE 1.9, CE 1.10, CE 2.7, CE 2.8, CE 2.9, CE 3.8, CE 3.10, CE 3.11, CE 3.15, CE 3.16
	Upheld the codes of practice by way of following the engineering requirements while carrying out the design responsibilities.	CE 1.12, CE 2.11, CE 2.12
	Recognize the significance of safety and followed the safety procedures	CE 2.12, CE 3.21
	Controlled distinctive activities of the project through plans	CE 1.7, CE 1.9, CE 1.10, CE 1.13, CE 2.7, CE 2.14, CE 3.9, CE 3.19
PE2 ENGINEERING APPLICATION ABILITY		
PE2.1 Application of established engineering methods to complex engineering problem solving	I diagnosed and analyzed exclusive issues, achieved investigation for finding the root reason of the problems, and sooner or later developed the answers for resolving these troubles.	CE 1.11, CE 2.11, CE 3.13, CE 3.14, CE 3.15, CE 3.18
PE2.2 Fluent application of engineering techniques, tools and	Carried out secure work limits, and used gadget with severe care	

resources	to avoid any physical danger. I used specific software for the of entirety of responsibilities	CE 2.12, CE 3.21 CE 1.6, CE 1.7, CE 1.14, CE 2.7, CE 2.8, CE 2.9, CE 3.18
PE2.3 Application of systematic engineering synthesis and design processes	Performed the design activities. Followed the engineering standards for completing the layout responsibilities	CE 2.11, CE 3.13, CE 3.14, CE 3.15, CE 3.18
PE2.4 Application of systematic approaches to the conduct and management of engineering projects	I controlled the complex engineering activities successfully by implementing my engineering knowledge I successfully managed different activities of the project	CE 1.10, CE 1.13, CE 2.12, CE 2.13, CE 2.14, CE 3.12, CE 3.19, CE 3.20 CE 1.7, CE 1.9, CE 1.10, CE 1.13, CE 2.7, CE 2.14, CE 3.9, CE 3.19
PE3 PROFESSIONAL AND PERSONAL ATTRIBUTES		
PE3.1 Ethical conduct and professional accountability	Followed the engineering accountabilities Tried to work following the safety principles during all the projects	CE 1.12, CE 2.11, CE 2.12 CE 2.12, CE 3.21
PE3.2 Effective oral and written communication in professional and lay domains	Being proficient in English language, I prepared the project reports Attended project meetings and actively participated in discussions	CE 1.6, CE 1.14, CE 2.6, CE 2.15, CE 3.22 CE 1.6, CE 1.13, CE 2.6, CE 2.13, CE 3.19

PE3.3 Creative innovative and proactive demeanour	Become aware of new developments via research and coordination with experts	CE 1.13, CE 2.6, CE 2.13, CE 3.19, CE 3.20
PE3.4 Professional use and management of information	Being conscious with documentation norms, I prepared project documents	CE 1.6, CE 1.14, CE 2.6, CE 2.15, CE 3.22
PE3.5 Orderly management of self, and professional conduct	Managed the project activities. Planned, and accordingly divided the tasks	CE 2.14
PE3.6 Effective team membership and team leadership	Utilizing my leadership skills. I well managed my team	CE 1.10, CE 1.13, CE 2.12, CE 2.13, CE 2.14, CE 3.12, CE 3.19, CE 3.20