DESIGN AND MANUFACTURING OF DRIVE CENTER MANDREL

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Abstract

In The Manufacturing Of Sleeve Yoke 1650 Many Problems Were Faced During Assembly And Disassembly Of Sleeve Yoke And Mandrel. The Assembly Being Too Heavy Requires Two Operators. Also, There Is Potential Danger Of Assembly Falling Down Leading To Damage To Life And Property. Moreover, The Idle Time Per Unit Production Is More Than Expected. Therefore The Aim Of Our Project Is To Design And Manufacture A New Mandrel Which Will Solve All The Problems And Increasing The Productivity. Splined Live Centre Technique Is Used To Design The New Drive Centre Along With The Mandrel Block .

Keywords—*Sleeve Yoke And Mandrel Assembly, Heavy, More Ideal Time, Splined Live Centre Technique, Mandrel Design, Mandrel Manufacturing.*

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1. INTRODUCTION

Automobiles Are The One Of The Most Essential Mode Of Transport In Our Day To Day Life. Being Made Of Number Of Components And Systems Like Engine System, Transmission System, Exhaust System, Etc They Are Used To Transfer Engine Power To Transmission System To The Wheels Of The Automobile.

Lakshmi Moriseiki SL-3 Is Used For Manufacturing Of Sleeve Yoke 1650, Which Is Used By Various Automobile Industries Like Ashok Leyland, Tata Motors, Mahindra And Mahindra, Maruti Suzuki, Etc.

1.1 Sleeve Yoke Assembly

A Sleeve Yoke Assembly For A Vehicle Drive Train Assembly Includes A Yoke Shaft That Has A Shaft Portion With A Number Of External Splines Formed There On. A Hole Has A Number Of Internal Splines, That Is Connected To The Yoke Shaft For Rotational Driving Movement. There Consist Of A Hollow Weld Ring Is Attached To Yoke Shaft For The Rotating Movement. The Weld Ring Permits Lubricant For The Splined Connection. A Convoluted Boot Is Provided To Prevent Foreign Material From Entering Into The Splined Connections. A Sleeve Cup Is Used To Seal The Transitory Member And Shaft Proportion Of Toke Shaft. To Retain The Position During Use, A Flange Portion Is Used.

1.2 Splined Live Center

Splined Live Centre Technique Is One Production Methods For Reducing The Idle In A Manufacturing Process. It Provides A Rapid And Efficient Way Of Converting A Manufacturing Process From Running The Current Product To Running The Next Product. This Rapid Changeover Is Key To Reduce Production Lot Sizes And Thereby Improving Flow. The Present Production System Like Just-In-Time Manufacturing Demands Smaller Production Quantities Which In Turn Mean More Setup Times (Non-Productive Time). Quick Changeover Which Is Also Referred To As Setup Reduction, Focuses On Eliminating Or Reducing Non Value Added Activities During The Setup. This Helps Operator To Efficiently Assemble And Disassemble The Sleeve Yoke In The Mandrel. The Basic Aim Is To Reduce The Idle Time On A Machine. There Are Two Types Of Setups: Internal And External. Internal Setup Activities Are Those That Can Be Carried Out Only While The Machine Is Not Performing Any Operation On The Product, While External Setup Activities Are Those That Can Be Done While The Machine Is Performing An Operation On The Product. The Basic Aim Is To Make As Many Activities As Possible From Internal To External And Also Concluded That Setup Reduction Is A Tool Which Is Universally Applicable.

2. OBJECTIVE

The Objective Is To Design And Manufacture A Drive Centre Assembly For Improved Operation Sequence And Work Process Having Following Characteristics

- Stresses Under Permissible Limit During The Operation.
- Improving Operation Sequence.
- Reducing The Work To Only One Operator.
- Reducing Ideal Time.
- Improving Productivity And Hence Cost Saving.

Fig-1: Lakshmi Mori-Seiki SL-3

Machine Details And Operational Sequence

2.1 Specifications

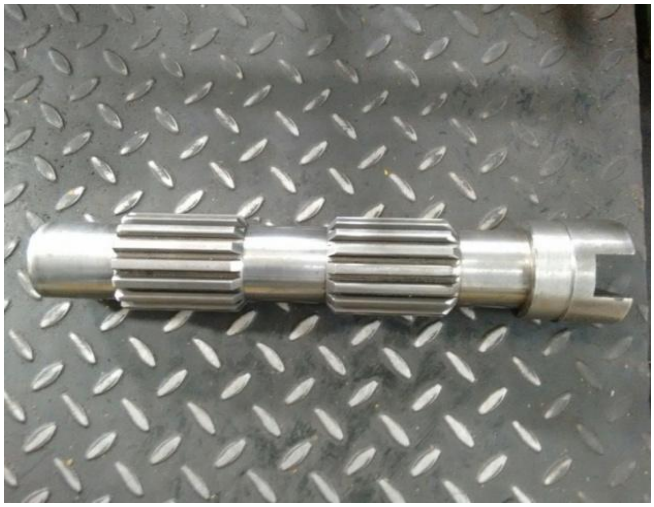

Fig-2: Sleeve Yoke

TABLE-1: SPECIFICATIONS

Chuck Size	8”
Max. Swing	22.4"
X-Axis Travel	6.3"
Z-Axis Travel	21.6"
Spindle Bore	2.2"
Spindle Speed	3,500 Rpm
Main Motor	20/15 Hp
Turret Positions	12
Machine Weight	9,240 Lbs.
Equipped With	Fanuc 6t Cnc Control, 8" 3-Jaw Chuck
Machine Dimensions	3.8 M*2.4 M* 2.0m
Machine Weight	5 Ton

3. JOB SPECIFICATIONS

Fig-3: Mandreal

- Material : Cast Iron- SG600
- Weight: 6.905Kg
- Chemical Composition:

1. C : 3.40-3.85%
2. P : 0.10% Max
3. Mn : 0.10-0.30%
4. S : 0.02% Max
5. Si : 2.30-3.10%
6. Mg : 0.07% Max
7. Iron-Balance

- Tensile Strength = 600N/Mm2
- Hardness: 200-260 BHN
- Use: Power Transmission In Ashok Leyland Heavy Vehicles.

4. MANDREL SPECIFICATION

- Material: 20 Mn 2
- Weight: 8.4Kg
- Tensile Strength : 500-650 N/Mm^2
- Hardness : 300 BHN
- Chemical Composition:
- C : 0.17-0.24%
- Si : 0.17-0.37%
- Mn : 1.40-1.80%

4.1 OPERATING SEQUENCE

[1]. Sleeve Yoke Is Placed Vertically On The Table.
[2]. Mandrel Is Inserted In Sleeve Yoke & Tail Cap Is Inserted To Adjust The Length Of Sleeve Yoke.
[3]. Whole Assembly Is Lifted By 2 Operators. One Matches Drive Centre And Other Operator Clamps The Job.
[4]. Operation Cycle Is Completed.
[5]. Again 2 Operators Are Required To Declamp The Job Assembly.

5. OBLEM DEFINITION

Our Project Team Identified The Following Five Biggest Problems In The Changeover Process.

Heavy Assembly

[1]. Earlier It Was Seen That The Weight Of The Assembly Was Very Heavy I.E. 15 Kg
[2]. Weight of Sleeve Yoke = 6.905 Kg.
[3]. Weight of Mandrel with Cap = 8.405 Kg.
[4]. Weight of Sleeve Yoke + Mandrel = 15 Kg.

It Was Very Difficult For The Operator To Lift The Assembly Carefully And Fit In The Centers Properly.

More Ideal Time

In Case Of CNC Machine, The Loading And Unloading Of The Job Assembly Is Done Manually And Requires A Lot Of Human Effort And Consumes Comparatively More Time With Human Intervention. Moreover Holding The Mandrel Vertically On Table, Taking Care It Doesn't Fall And Then Inserting The Sleeve Yoke In It. Carefully Lifting The Assembly And Matching Such A Heavy Assembly Between Centers And The Door Of The Machine Closes. After The Operation Is Done The Assembly Is To Be Held First By Two Operators And The Unloaded From Centers. Removing The Cap And The Mandrel Is Kept Aside And The Job Is Kept In The Trolley Which Was Tedious And Time Consuming.

Number of Persons Involved

In The Current Changeover Process The Persons Involved Are Only Two.The First Person Holds The Mandrel And Other Inserts The Sleeve Yoke And Then Both Of Them Lift The Whole Assembly Take It To The Machine. One Operator Uses Both His Hands And Other Holds The Assembly With One Hand And Adjust Dead Center Of Tail Stock From The Control Panel Simultaneously. Moreover Due To Small Door Opening Of The Lathe Machine It Was Difficult For Two Operators To Stand And Load And Unload The Assembly. Further On The Workers Age Is Also A Main Criteria Which Contributes Towards The Problem.

Operator Fatigue

Such A Heavy Assembly Is To Be Loaded And Unloaded For Every Single Job, Which Was Very Tiring And Tedious To Operator Which Constitute The Measure Problem And Thus Low Operator Moral Due To Strenuous Operating Sequence.

Safety Concern Due To Heavy Assembly & Potential Danger Of Assembly Falling Down In Case Of Assembling The Sleeve Yoke And The Mandrel There Are Strong Chances Of The Mandrel Falling Down Or The Sleeve Yoke And The Mandrel Falling Down Even If There Is Small Amount Of Carelessness. In Such A Case It Would Damage The Sleeve Yoke And The Mandrel. Moreover If It Falls On The Operators Feet It Would Injure His Feet. Potential Threat Of Damage To Life And Property Was Seen.

6. ANALYSIS OF OLD MANDREL

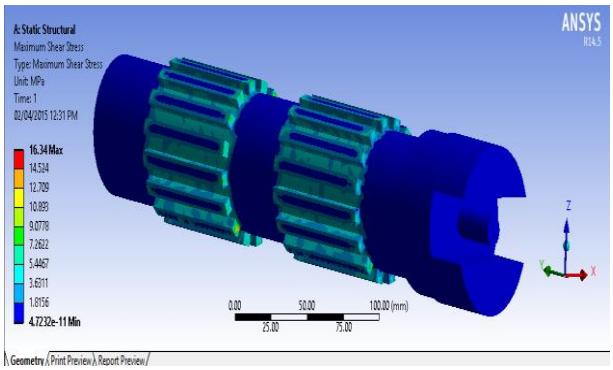

Fig-4: Maximum Shear Stress for Old Mandrel

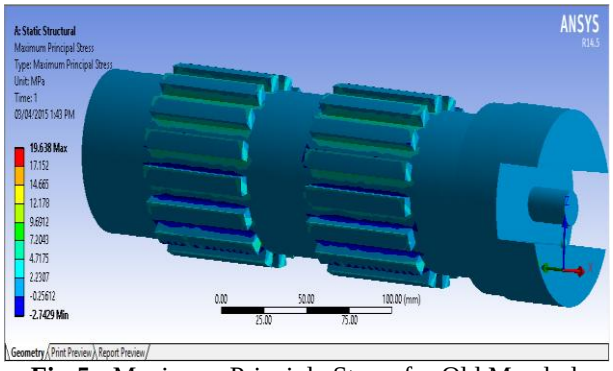

Fig-5: Maximum Principle Stress for Old Mandrel

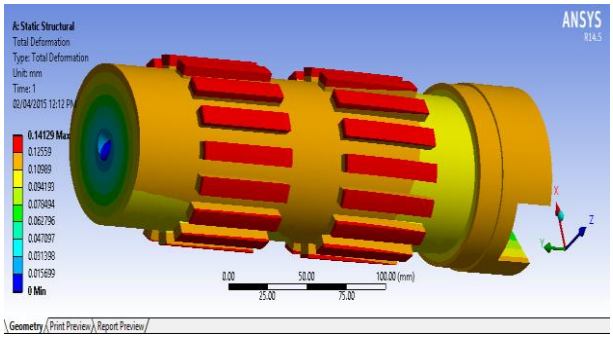

Fig-6: Total Deformation for Old Mandrel

7. PROBLEM SOLUTION

The Possible Solution For Above Problem Is As Listed Below:

7.1 Designing A Drive Center

As The Problems Stated Above It Was Necessary For Us To Design A Drive Centre Which Is Light In Weight, So That The Problems Faced Would Automatically Gets Reduced. As The Total Weight Of The Assembly Weight Gets Reduced The Number Of Persons Involved Will Also Reduce, I.E. It Will Be Sufficient For Only One Person To Lift The Assembly And Fit In The Drive Centre. Moreover A Lot Of Time Goes In Carefully Setting The Assembly Of The Mandrel In The Sleeve Yoke. The Safety Concern Due The Heavy Weight And The Assembly Falling Down Is Loss Of Life And Property. Less The Weight Less Will Be The Operator Fatigue Because The Operator Will Have Lift Less Weight Every Time.

So The Main Concern To Design A Drive Centre Having Weight As The Most Important Factor While Designing, That Could Take The Cutting Forces With Deflection In Permissible Limit, Simple To Assemble And Dissemble So The Chances Of Assembly Falling Down And Damage To Life And Property Is Reduced To An Extent. The New Mandrel Design Should Also Provide Drive To The Mandrel To Felicitate The Turning And Threading Operation.

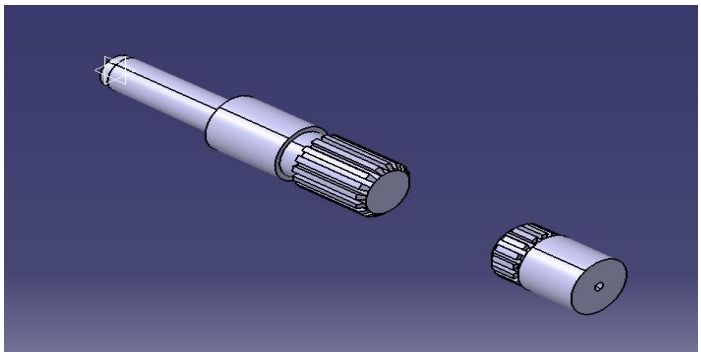

Fig-7: New Drive Center-Mandrel

8. MANUFACTURING OF DRIVE CENTRE

The Design Should Satisfy All The Technical Requirements I.E. Stresses And Deflection In Permissible Limit. The Manufacturing Starts With Selection Of Proper Drive Centre Material Which Can Withstand The Forces Incurred While Operations Are Performed On The Sleeve Yoke.

The Manufacturing Process Has Been Carried Out On The Material Selected By Design Calculations And As Per The Requirement In Following Sequence.

1) Shaping Processes

Initially Shaping Processes Like Cutting, Facing, Turning, Tapering, Centering, Chamfering Had Been Carried Out As Per The Design Requirement, And Selected Dimensions.

2) Heat Treatment

After Completing Shaping Processes, Surface Hardening And Quenching Has Been Done To Increase The Hardness Of The Drive Center.

Heat Treatment Of New Mandrel Consists Of Surface/Case Hardening, Flame Hardening And Quench Hardening.

3) Surface Finishing

After Completing The Manufacturing Processes And Heat Treatment Of New Drive Centre, Surface Finishing Processes Has Been Done By Grinding With Particular Grade Grinding Wheel And Required Technique. Here We Had Used Between Centre Grinding Which Is Explained In Details In Manufacturing Section Later On.

Fig-8: New Drive Centre Mandrel And Mandrel Block With Sleeve Yoke

9. ANSYS ANALYSIS OF THE NEW DRIVE CENTER MANDREAL WITH MANDREAL BLOCK

The Figures Shown Below Shows The New Design Of Drive Centre Mandrel With The Mandrel Block Which Supports The Sleeve Yoke On Tail Stock. The Later Figures Shows The ANSYS Analysis Considering All The Forces And The Moment Of The Same.

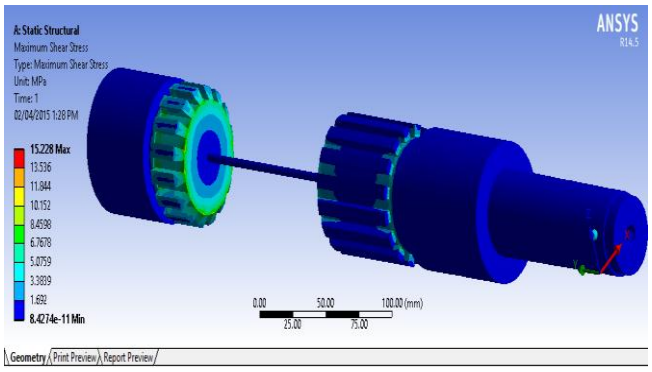

Fig-9: Maximum Shear Stress For New Drive Center

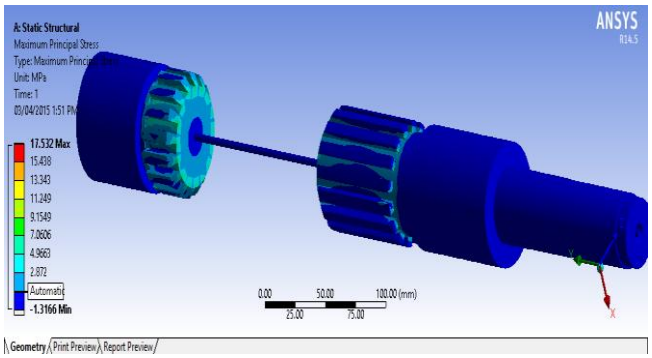

Fig-10: Maximum Principal Stress For New Drive Center

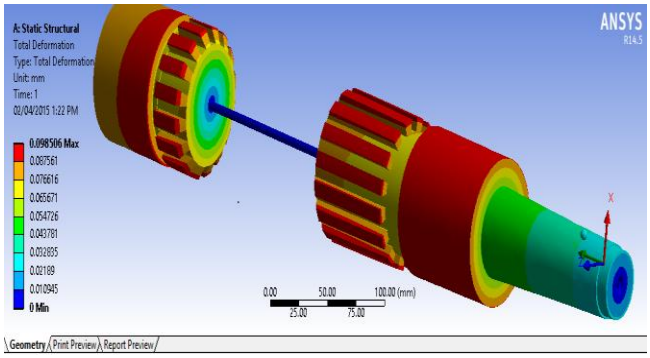

Fig- 11: Total Deformation For New Drive Center

10. ANALYSIS AND DEPLOYMENT

A. Setup Time Reduction

As The Internal And External Activities Were Observed And Studied Various Methods Were Thought Of To Reduce The Problems Faced And A New Concept Of Splined Live Centre Technique Was Used And Implemented.

A Splined Live Centre Was Designed To Check The Suitability For The Required Operation.

Before The New Design Was Made, Analysis Of The Changer Over Process Was Done And The Results That Were Obtained Which Indicated That The Initial Process Was Very Time Consuming And Took A Lot Of Human Efforts. Hence The Analysis Was Done By Visual Study, Identification And Separation Of Internal And External Activities, Converting Internal To External Activities And Elimination Of Internal Activities. The Changer Over Processes Are To Be Studied With The Help These Four Steps Mentioned Above. The Four Step Approach Is Studied Below As Per The Work Done In The Manner Which Is Been Carried Out Or Performed.

B. Analysis Of The Current Setup Process (Visual Study)

In Ordered The Analysis Current Setup Process, Visual Study Is Defined As Proper Observation Of The Processes In The Manner They Are Carried Out. Hence Properly Trained Operator Was Chosen For The Project Span. It Was Also Observed That The Standard Operating Procedure Was Not Available With The Operator. So That SDW Was Decided To Be Implemented After The Setup Reduction So That Only The New Proposed Changeover Methods Are To Be Included In If Along With The Reduced Setup Time, After Reduction In Setup Time. The Entire Process Was Successfully Observed And The Setup Time Is Noted Of About 8-9 Minutes.

TABLE-2: SETUP PARAMETERS AND TIME REQUIRED

SR. NO	PARAMETERS OF SETUP	TIME REQURIED
1	Sleeve Yoke Is Lifted And Placed Vertically On The Table	0.21 Min
2	Mandrel Is Inserted In Sleeve Yoke	0.16mins
3	Tail Cap Is Inserted	0.04mins
4	Lifting The Assembly	0.08mins
5	Drive Matching	0.40mins
6	Job Clamping	0.05mins
7	Door Closing	0.04mins
8	Load Program And Start Machine	0.50mins
9	Job Operation	5.2mins
10	Machine Stops	0.01mins
11	Door Opening	0.04mins
12	Holding The Assembly	0.12mins
13	Job Unclamping	0.45mins
14	Machine To Table	0.05mins
15	Removing Cap And Mandrel	0.45mins
16	Keeping Sleeve Yoke In Trolley	0.12mins
Total Time In Mins.		10.12mins

C. Indentify And Separate Internal And External Activity

In The Next Step, The Captured Video Was Played In Slow Motion And Total Number Of Step In The Entire Setup Were Noted Down Along With Time Required For Each Step To Completed With Help Of Given Stopwatch The Total Number Of Steps In The Entire Setup Were Noted Down Along With The Time Required With Each Step To Be Completed With The Help Of Given Stop Watch The Total Number Of Steps To Be Conducted Were 20 Including Both Internal And External Activities. After Identification Of 3 Internal And 7 External Steps Were Observed And Noted Down.

TABLE-3: IDENTIFY AND SEPARATE INTERNAL AND EXTERNAL ACTIVITY

SR.NO	PARAMETERS OF SETUP	Internal /External
1	Sleeve Yoke Is Lifted And Placed Vertically On The Table	Internal
2	Mandrel Is Inserted In Sleeve Yoke	External
3	Tail Cap Is Inserted	Internal
4	Lifting The Assembly	Internal
5	Drive Matching	Internal
6	Job Clamping	Internal
7	Door Closing	External
8	Load Program And Start Machine	Internal
9	Job Operation	External
10	Machine Stops	External
11	Door Opening	External
12	Holding The Assembly	Internal
13	Job Unclamping	Internal
14	Machine To Table	External
15	Removing Cap And Mandrel	Internal
16	Keeping Sleeve Yoke In Trolley	Internal

D. Convert As Many Internal And External Activities To External As Possible

In Step 3, After All The Activities Have Successfully Been Identified And Separated, Then The Internal Activities Are Converted Into External Activities Possible

E. Eliminate Wastes/Simplify Internal Activities

This Is A Very Crucial So Step For The Setup Reduction As All The Required Action Must Be Taken In This Steps Only. Here The Wastes Are Identified Which Ultimately Who Eliminated, Result In Simplifying The Internal Activities The Four Types Of Waste Which Are Eliminated Are Over Production, Inventory, Waiting, Motion ,Transportation, Rework, Over Processing, External Waste. The Table Below Shows Elimination Of The Wastes

F. Eliminate Wastes/Simplify External Activates

After The Compete Implementation Of The Mandrel Which Is A Splined Live Centre Which Is Fixed Properly In The Chuck, The Time Required From The First Step To The Last One Was Observed And Noted Down.

TABLE-4: TIME REQUIRED FOR SETUP

SR.NO	PARAMETERS OF SETUP	Time	Internal /External
1	Sleeve Yoke Is Lifted And Inserted In Drive Centre	5 Sec	External
2	Mandrel Block Is Inserted In Sleeve Yoke	2 Sec	External
3	Drive Matching And Job Clamping	3 Sec	External
4	Door Closing	2 Sec	Internal
5	Load Program And Starting	5 Sec	Internal
6	Job Operation	312 Sec	Internal
7	Machine Stop	2 Sec	Internal
8	Door Opening	2 Sec	Internal
9	Holding Mandrel Block And Unclamping	5 Sec	External
10	Sleeve Yoke Removal	5 Sec	External
11	Keeping Sleeve Yoke In Trolley	2 Sec	Internal
	Total Time In Minutes	5.78 Mins.	

11. CONCLUSION

The Primary Aim Of This Project Was To Design And Manufacture A Drive Centre For Manufacturing Process Of Sleeve Yoke On Moriseiki SL-3. First Of All The Design Is Safe And Is Under Permissible Limit. The Idle Time Between Two Manufacturing Operations On Sleeve Yoke Was Reduced And Subsequently Reduced The Cost And Time Of Operations.

The Design Made The Operator Work Easy And Eliminated The Use Of Two Operators To One Operator. Thus Saving The Labour Charges. The Clamping And Unclamping Is Easy And Less Strenuous And Less Fatigues' As The Process And Weight Of The Assembly Is Considerably Reduced. Thus Ensuring Safety And Damage To Life And Property Is Reduced And The Overall Efficiency And Productivity Of The Whole Process Increased.

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