# SMART PRELOADING OF AN AUTOMOBILE CAM CHAIN STATION

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***Abstract—**During Manufacture, chains are routinely "preload" to a definite percentage of their "tensile strength" to help correct assembly inaccuracies, Increase endurance life and to reduce initial running-in wear. Cam Chains are used for timing applications in two wheeler engines for timing the opening and closing of valves – they connect the camshaft to the crankshaft. These chains will benefit from accurate length control as this directly affects engine efficiency, and tight tolerances on length are valued by the engine manufacturers.A need was felt to "smart load" these chains during the preloading process with a view to improving length control. This involves varying the load at the preload station depending in the length before preloading within acceptable limits.This project aims at designing a new concept preloading station for "smart preloading" a motorcycle or scooter cam chain through the following steps:*

1. *Estimate /validate the effect of preloading by analysis. Test to arrive at desirable load limits*
2. *Study the drawbacks/problems of the existing method of preloading.*
3. *Arrive at a superior/novel preloading concept, Make a detailed Design.*
4. *Build a model which can meet productivity requirement.*

***Keywords— Automobile; CAM Chain Station; Preloading***

## 1. INTRODUCTION

After assembly, we apply an Initial load in the chains, called preload thus; loading approximates the recommended maximum loading in service. Preloading is also done to align the various chain components such as pins, bushing and link plates. It is done also to minimize the Initial stretch of chain in service. A self-locking mechanism is made to hold the chain after every successive links on a chain as per the requirement. A linear load is applied to the chain once the chain is held on the station.
Loads are uniformly distributed to the chain according to the requirement. During preloading operation the chains are locked with the help of the idler gear which is designed in such a way beneath the table. There is a supporting frame to hole the test bench firmly when the linear load is applied to the fixed chain during preload operation. The automobile chains are subjected to preloading before it is installed in any vehicle. In the existing setup, the chains are measured in phases. In phase I, by using LVDT the measurement is made by the change in Centre Distance Measurement value since the length between the sprockets are preset according to the length of the chain and Pitch Circle Diameter of the sprockets are manually calculated. This length variation found in LVDT will be sent to servomotor which is in Phase II by HMI. Here in Phase II, The chains are stopped by applying a brake and clutch is also used to avoid reversing of the chain during preloading operation and the load is applied to the chain as per the length variation between 30 – 50% of the Braking load of the chain (i.e.,) the tensile strength of the material. After preloading the chains are again rolled to the Phase III where, the preloaded chains are measured again and the continuity is checked by placing a Proximity Sensor. The reason for the failure in this setup is, it has multiple phases where the loading inaccuracies are more and the chains are not properly stopped. Hence, few links of the chain are held on the sprocket and not getting loaded to the desired value.

Here, we are eliminating more phases and a single station is made where the measuring, preloading and post inspection is made simultaneously. A table is made with two sprockets on the top which is driven by a gear train beneath the table. The lengths in between the sprockets are the length of the chain form the Centre of the Sprocket.
The Idler gear makes the sprocket to rotate in same direction when the load is applied linearly over the chain. A brake is automatically applied upon the load to the chain by resisting the movement of the idler gear beneath the table. This will hold the chain from moving its position. Hence, the load is applied throughout the chain evenly. Hence, the load is applied throughout the chain evenly. The load distribution of a cam chain in general is distributed from the bush to the inner plate and the pin to the outer plate.

## 2. LITERATURE REVIEW

Odusote et al. (2012) studied the impact of medium carbon steel and have examined the heating between soaked in a muffle furnace before quenching in palm oil and water separately. The mechanical behavior of the samples were investigated using universal tensile testing machine for tensile test and the microstructure of the quenched samples was studied using optical microscope. The tensile strength and hardness values of the quenched samples were relatively higher than those of the cast samples, this critically suggest some improvement on the mechanical properties of the samples taken for the study. However, the tested samples are quenched in palm oil which displayed better properties and is compared with that of water-quenched samples. These behaviors were noted an found to the fact that the carbon particles in palm oil quenched samples were more uniform and distributed more evenly, thus indicating the formation of more pearlite structure than those particles are quenched in water and the results are obtained. During quenching process the formation of mechanical properties are with the good structure and material characteristics.

Ogundare et al. (2013) made an attempt to improve on the mechanical properties of structural materials and to make a test which has been one among the major tests required in assessing the tensile properties to find the behavior of any mechanical property. Recently for the evaluation of fracture toughness of any selected ferrous materials, the same method was being adopted on a different other sample property. After several tensile testing and real time experimentation, it is observed that the machineries are manufactured for such test from manual operation to Computer Numeric Control (CNC) interface type for any further automation. These following results expected and received are agreed upon to have been influenced, among other factors which by then chosen at any selected strain rate.

Wiesner (1999) studied the effects of loading rate on tensile properties and fracture toughness of steel and arrived at a conclusion that dynamic loading rates affect both the material resistance and the structural response of engineering components. It is the combination of two above said influences that determines the structural behavior. The tensile structure and micro structural properties of mild steel of carbon composition 0.19% which has have been studied by varying the strain rates and by influencing with initial emphasis on its necking behavior. From the results, It is been concluded that the strain rate of 10 mm/min has proven to possess the extreme hardness and peak load but lowest yield strength. However, the elongation was observed to increase as the strain rates increases as the micrographs showed that 5 mm/min strain rate produced the least pearlite grains count, followed by that strained at 20 mm/min, then 30 mm/min and most pearlite grains count was analyzed with that of strain rate 10 mm/min. Consequently, the area covered by ferrite grains was highest in 5 mm/min strain rate and least with that 10 mm/min strain rate. Mild steel with 0.19%C will display optimum structural performance under loading rate of 10mm/min.

## 3. Experimentation

The Above designed machine is given for manufacturing and fabricated. I then started my experiments by taking 6 samples of various production line of a cam chain as suggested. The varying load ranges between 40- 80 kgs is applied on the cam chain by every incremental load of 5 kgs.

### *3.1 Instruments used for this experiment*

- 1m Vernier caliper (To Measure the length of the chain)
- Bevel Protractor (For Angle Measurement)
- Screw Gauge (For Deflection Measurement)
- Feeler Gauge (For Deflection Measurement)
- Test Bench Setup ( To Carry out the Experiment)
- Load Range between 40 -80 kgs. (For weight Increments)
- 6 Sample Cam Chain Model No: B04C Automobile Cam Chain/Timing Chain

The Jaw of the vernier is Customized since, the default vernier jaw has a tongue of 10mm on the either side but, the width between plates are 3mm only. A Jaw is made and also held firm using a grub Screw attachment. Without disturbing the setup throughout the process the Iterations are made to get the precise results.

The Value of the vernier is Calibrated with 11.54mm since the wall thickness is manufactured with a wall thickness of 5mm on the either side. So, the Cummulative reading measured is subtracted with 11.54mm as shown in the figure Below

Figure 1 Meter Vernier Caliper – Customized Jaw

As shown in the figure below the chain is rolled into the preloading station test assembly manually and the pitch with no load condition is marked by using a paint marker. The marked chain is now taken to the chain length measuring table where in the actual length of the chain before loading is measured. Surface Plates are kept as a datum for Measuring the parameters like Linear and Angular deflection by using feeler Gauge and Bevel Protractor. The Preset Datum is not disturbed throughout the Experiment.

Figure 2 Preloading Setup – No Load Condition

The Subsequent weight from 40.200kgs is loaded on the cam chain and the Linear & Angular displacements are noted down. Then the chain is taken to the chain length measuring table to measure the change in length by using vernier caliper. One end of the chain is pivoted in the customized fixed probe and the other weight is held by a dead weight to get a firm stretch of the chain. This Iteration is followed by every incrememtal load og 5kgs till 80kgs to measure the length of the chain and a table is made.

By continuing this Iteration for 6 more random chains picked from the manufacturing unit the values are tabulated. For accurate results the weights are set several times in a random sequence and repeatability is also noted. This tabulation indicates the level of length variation of any particular chain which has been experimented. The indicated paint marker shows the exact pitch for which a chain should be installed, Loaded and Measured. Angle of deflection is used to find the force which is needed to load the chain when automating this setup during manufacturing level optimization as an Input to the Special Purpose Machine Builders. Linear delfetion is used to plot the load vs Displacment curve where the load necessity is studied along with the stress curves. This calibrated value can be a input for Programmable Logic Controller for load automation depending on the length of the chain. Similarly this test is carried on 6 random chains and a tabulation is made which consists of Angle of Deflection, Linear Deflection and Change in length of the chain.

Figure 3 Images of The Smart Preloading Experimtment Setup Table weiging range from (40-80 kgs)
Measuring Instruments


Figure 4 Bevel Protractor

Figure 5 Feeler Gauge

After the experiment the tablulation is made and those values are checked with repeatablity for accurate results. A graph is made for the Load Vs Displacment which gives the values of chain in the length of the chain and a graph is plotted and found that there is a minimum legth variation on th chain. Sfatey gaurds are also designed in such a way the chain can easily along its path without damaging the hands of the operator. This setup acts as a Poka-yoke for the operator even if the setup is mishandled. Surfae plates are placed in the base table as shown in th fig (4.2.4) where the Preload station is placed for the experiment purpose. The surface plate is also conidered to be the datum reference for measuring the different values of the chain during preload condition. The bottom part of the housing table has three gear teeth as shown in the figure (4.2.5) with one as the idler for the chain to move in only one direction. The Idler gear itself will act as a brake which will not make the chain to roll out from the position where it is been set while loading.

## 4. Part Models of an Assembly

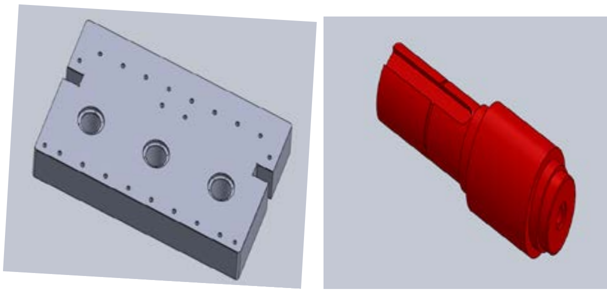
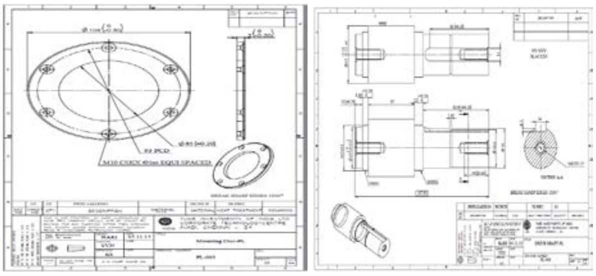
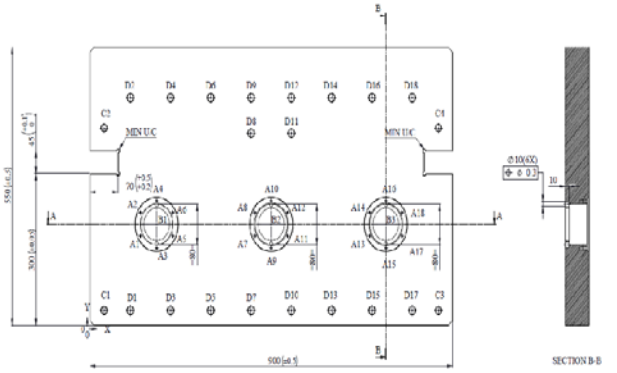


Figure 6 Part Model





CAD Model of the Pre Loading Station

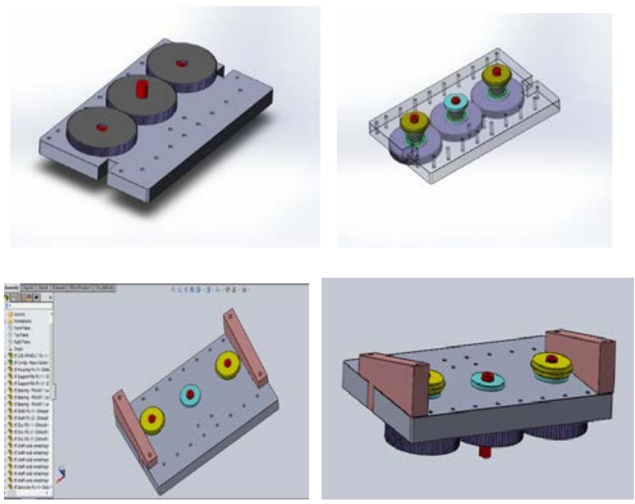


Figure 7 Assembly model

The above shown are the CAD models and are assembled in a sequence which holds the drive shaft along with the Gear Train bed and the sprockets to make the chain get into the loading action. Idler gear arrests the chain from moving from its desired place once it is fixed. The linear load applied to the chain makes the chain to hold it firm.

A Disc is mounted in the top of the housing to ensure the bearing which doesn't come out of the system when the load is acting. Side Support angle is been designed to hold the setup firm during linear loading

The Part modeling is made by using Solid works 2015 and the Assembly is made in the same. The Design and logic validation is done by the mentor in the industry which leads to the further movement of the project and that lead to the further movement of the project like assembly and those are made as a 2D drawing with all standard clearances and tolerances. Now, the station has been given to the vendor for manufacturing. Once, after the components are made it will be assembled in house and the tests and trials for loading the chains will be made. At this moment, the drive power supply is not given to the setup as this will be a manual indexing at the start for trials to practically validate the results. Further study on improving the test bench to make it more precise is also been studied.
Gear and Sprockets are wire cut so that 3D drawing is directly used for manufacturing those, and the other components are to be hardened and some are to be jig bored for parallelism to seat the fasteners.
Geometric dimensions and tolerances are carefully studied and mechanical component designs are made with Standards and tolerances are given according to the working accuracy.

By using solid works 2015 version the necessary part components are made and Gearteq software is used to make the sprocket and driving gear. Gears and sprockets are wire cut. So, manufacturing Technology for making necessary mechanical components is studied. Study of material is made to decide the category of material used to choose between shaft, housing, side support assembly and all ready to buy components like fasteners, Keyway, circlip.

Safety in manufacturing is being studied to ensure that the operator is not having any problem to use it. It is designed very compact for good aesthetics and ergonomically be able to operate with ease. The shop floor size is optimally reduced by implementing this station in the manufacturing process.

## 5. RESULTS

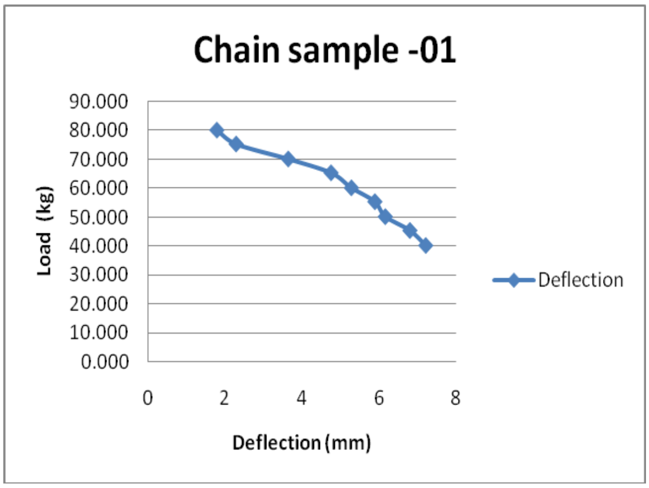



Figure 8 chain sample 1 (a)

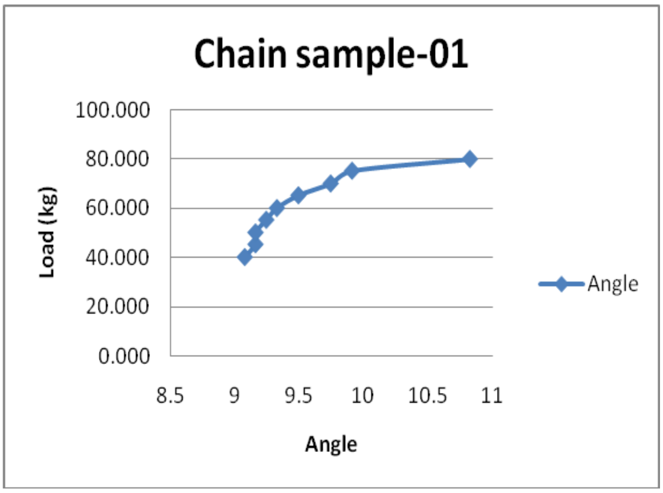



Figure 9 chain sample 1 (b)

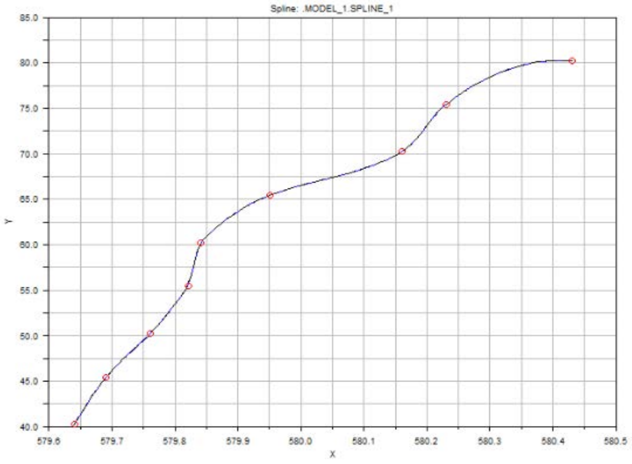



Figure 10 chain sample 1 (c)

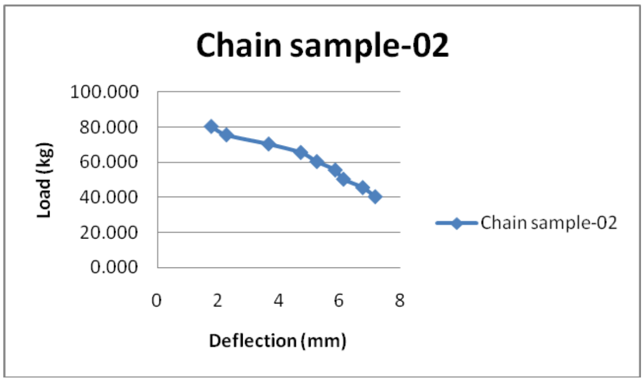



Figure 11 chain sample 2 (a)

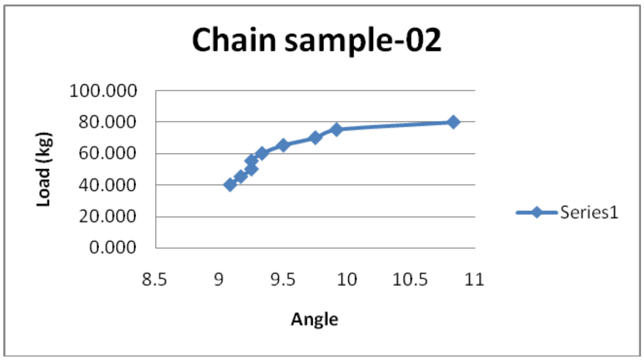



Figure 12 chain sample 2 (b)

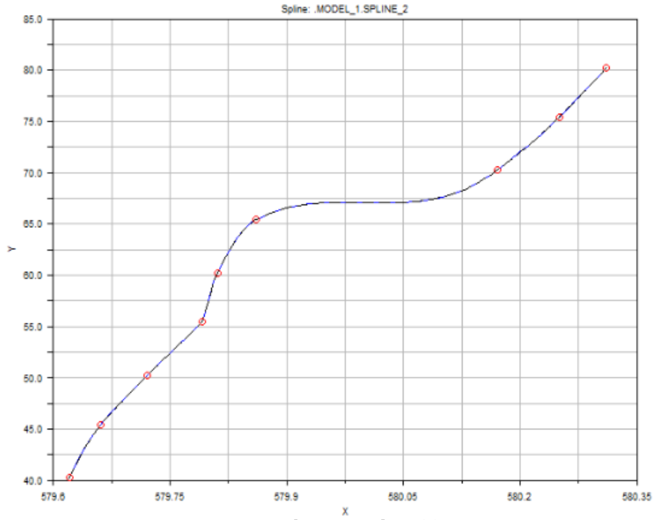



Figure 13 chain sample 2 (c)

## 6. CONCLUSION

The concept is proven by loading the chain till 80kg(i.e)15% of total ultimate tensile strength UTS to preload the chain to 0.5mm and future loads till 30% will be able to preload the chain according to necessity of the customer.

The above proven results will give you the brief idea of the experiment which shows the change in the length upon the load and the tabulation is made for the same.

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