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STUDY OF DIFFERENTIAL BEVEL GEAR THROUGH MACHINING METHOD

Mohd Abbas, Sanjeev Sharma, Vinit Kumar Sharma

***Abstract*— In this paper we have selected the machining method, a cost saving manufacturing process to produce straight bevel gears without any compromise with quality parameters, then validate the samples taken from vendor as per our design requirement and to increase Durability & Productivity of Straight Bevel Gears. To validated we have used tractor as a testing equipment and validate the gears to our design specification.**

***Index Terms*— Straight Bevel Gear, Spiral Bevel Gear Circular Pitch, Pressure Angle, Pitch Diameter, Tooth Parts.**

I. INTRODUCTION

Power is supplied from the engine, via the gearbox, to a driveshaft, which runs to the drive axle. A pinion gear at the end of the propeller shaft is encased within the differential itself, and it engages with the large *crown-wheel*. The crown-wheel is attached to a *carrie*r, which holds a set of three-four small planetary straight bevel gears. The three planetary gears are set up in such a way that the two outer gears (the side gears) can rotate in opposite directions relative to each other. The pair of side gears drive the axle shafts to each of the wheels. The entire carrier rotates in the same direction as the crown-wheel, but *within* that motion, the side gears can counter-rotate relative to each other.

Input torque is applied to the Crown wheel, which turns the entire carrier (all Blue), providing torque to both side bevel gears (red and yellow), which in turn may drive the left and right wheels, if the resistance at both wheels is equal, the planet gear (green) does not rotate, and both wheels turn at the same speed.

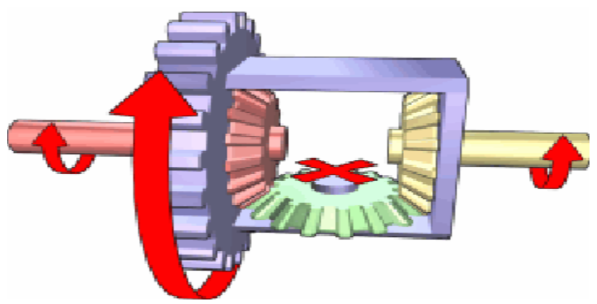

Figure 1: Differential Dynamics When Vehicle Runs On Straight Path.

If the left side gear (red) encounters resistance, the planet gear (Green) rotates about the left side gear, in turn applying extra rotation to the right side gear (yellow).

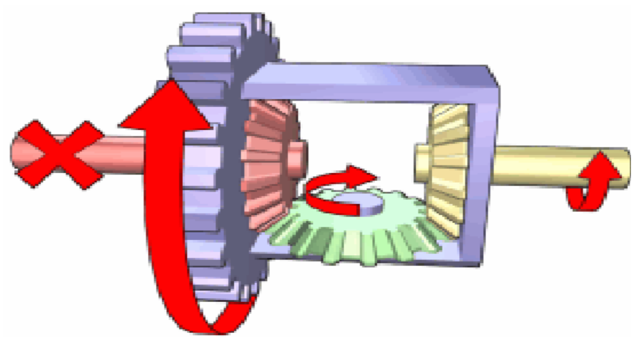

Figure 2: Differential Dynamics When Vehicle Takes Turn.

A general Gear manufacturing process contains the following process-

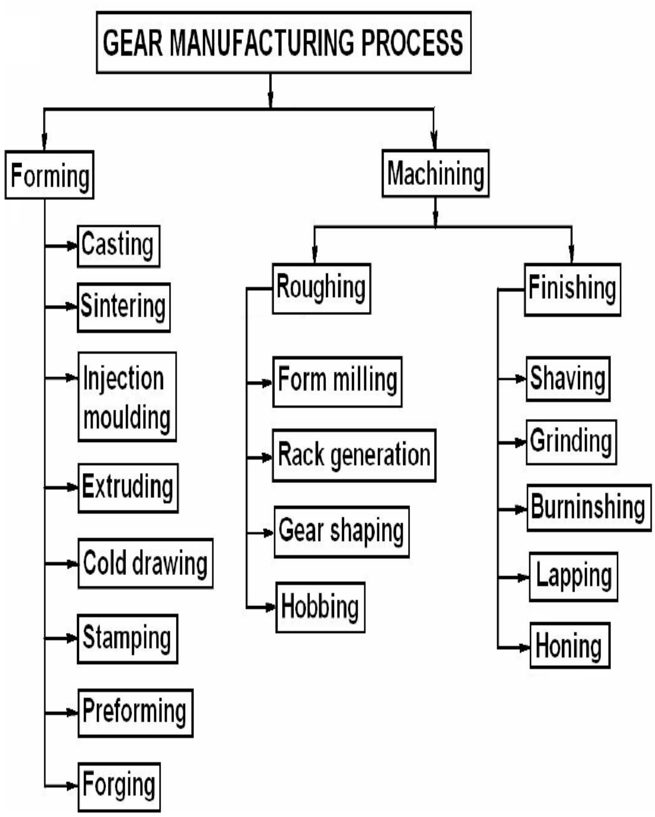

Fig3.Categories of Gear Manufacturing Process

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Mohd Abbas, Asst professor, Deptt of Mechanical Engg, Alfalah School of Engg and Technology, Dhauj Faridabad
Sanjeev Sharma, M.Tech.(Scholar) Manufacturing process and Automation, Dept of Mechanical Engg, Alfalah School of Engg and technology, Dhauj Faridabad
Vinit Kumar Sharma, Prof. & Dean Academics, Deptt. of Mathematics, SIET, Shamli

Machining: The bulk of power transmitting metal gears of machinery are produced by machining process from cast, forged, or hot rolled blanks. Refer Figure 3 for classification of machining processes. Roughing processes include milling the tooth shape with formed cutters or generating the shape with a rack cutter, a shaping cutter or a hob cutter. Despite its name, the roughing processes actually produce a smooth and accurate gear tooth. Only for high precision and quiet running, the secondary finishing operation is justified at added cost.

Roughing Processes: Roughing process consists of forming, generation, shaping and hobbing processes. By this method gears are made to an accuracy which is more than adequate for the slow speed operations. These processes are dealt here.

Form Milling: Forming is sub-divided into milling by disc cutters and milling by end mill cutter which are having the shape of tooth space.
To reduce costs, the same cutter is often used for the multiple-sized gears resulting in profile errors for all but one number of teeth. Form milling method is the least accurate of all the roughing methods.

Rack Generation: In rack cutter the tooth shape is trapezoid and can be made easily. The hardened and sharpened rack is reciprocated along the axis of the gear blank and fed into it while gear blank is being rotated so as to generate the involutes tooth on the gear blank.
The rack and gear blank must be periodically repositioned to complete the circumference. This introduces errors in the tooth geometry making this method less accurate than shaping and hobbing.

The process is limited to small gears since the length of the rack has to be equal to circumference of the gear at pitch diameter

Gear Shaping: Gear shaping used a cutting tool in the shape of a gear which is reciprocated axially across the gear blank to cut the teeth while the blank rotates around the shaper tool. It is a true shape-generation process in which the gear-shaped tool cuts itself into mesh with the gear blank .The accuracy is good, but any errors in one tooth of the shaper cutter will be directly transferred to the gear. Internal gears can be cut with this method as well.

Hobbing: Hob teeth are shaped to match the tooth space and are interrupted with grooves to provide cutting surfaces. It rotates about an axis normal to that of the gear blank, cutting into the rotating blank to generate the teeth.
It is the most accurate of the roughing processes since no repositioning of tool or blank is required and each tooth is cut by multiple hob-teeth, averaging out any tool errors. Excellent surface finish is achieved by this method and it is widely used for production of gears.

Straight Bevel Gear Generator: This machine has two reciprocating tools which Work on top and bottom sides of a tooth and are carried on the machine cradle. The cradle and work roll up together like a crown gear (a bevel gear in which tooth faces lie in one plane), rolling with the gear blank. At the top of roll, when a tooth has been completely generated, the work is withdrawn from the tool, and the machine indexed while the cradle is rolled down to the starting position. The operating cycle is repeated automatically until all the teeth in the gear have been cut.

The advantage of this process are that a previous roughening cut is not necessary, thus saving one handling of the blank, longer cutter life, improved quality of gear and less set up time.

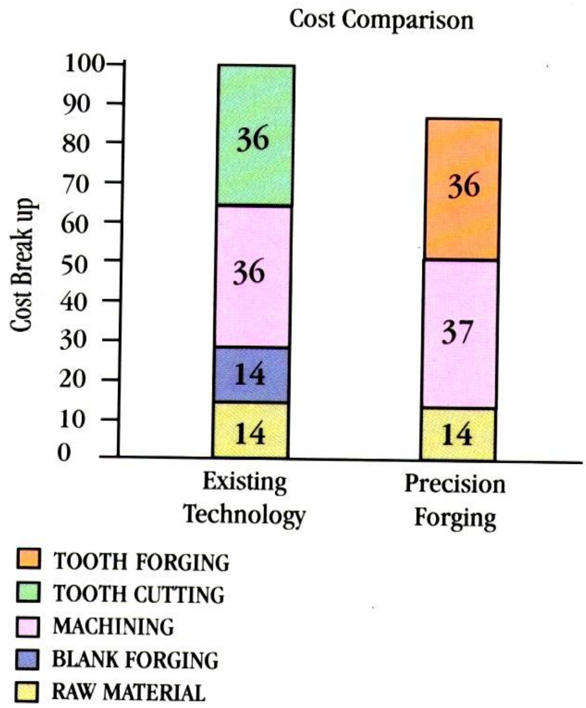

Figure.4 Comparison Cost Wise

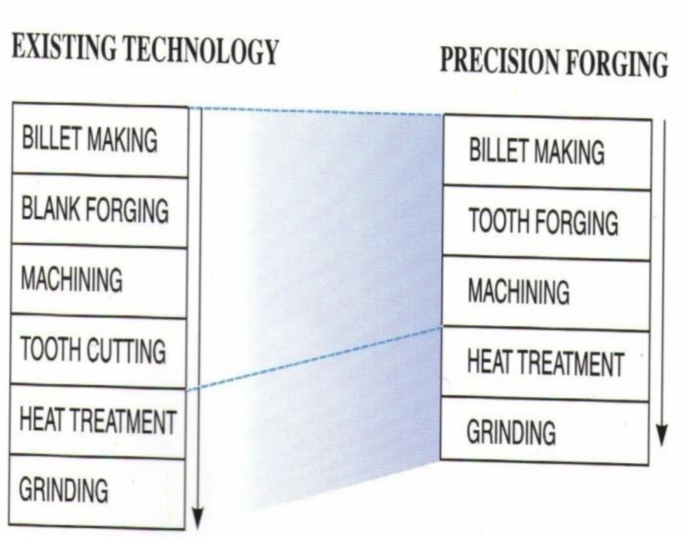

Figure.5 Comparison Process Wise

II. CONCURRENCE WITH VENDOR FOR DESIGN PROPOSAL

This includes reviewing the design on layout and finalizing the part drawings with Supplier.

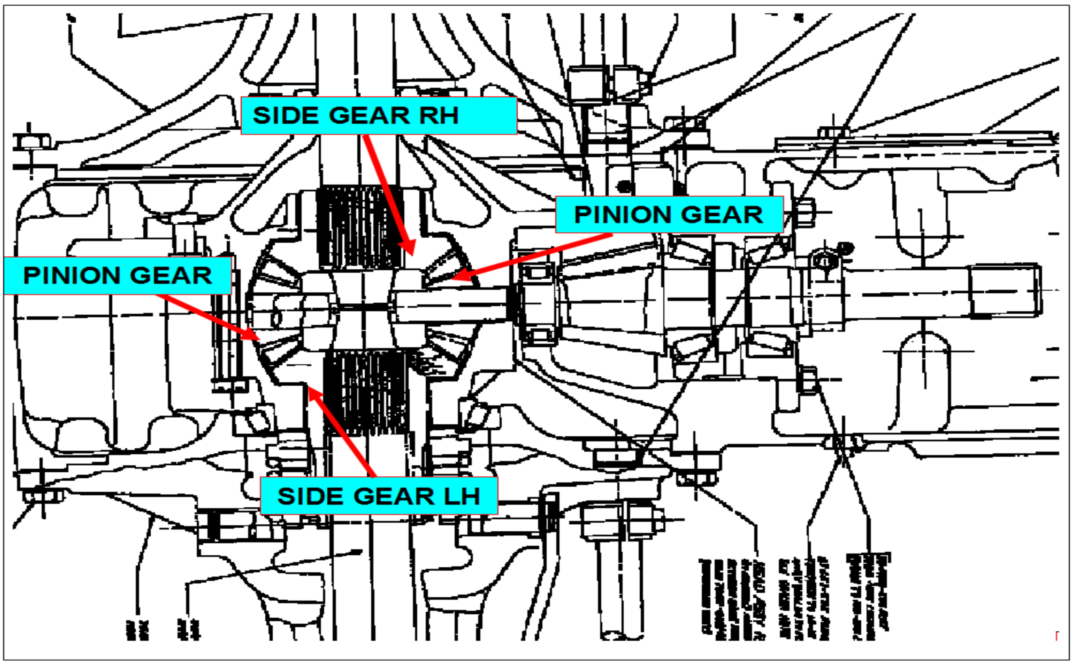

Figure 6 Layout of Differential Straight Bevel Gears.

This layout is studied by vendor and escorts jointly and finalize the drawings for side gears and pinion gears.

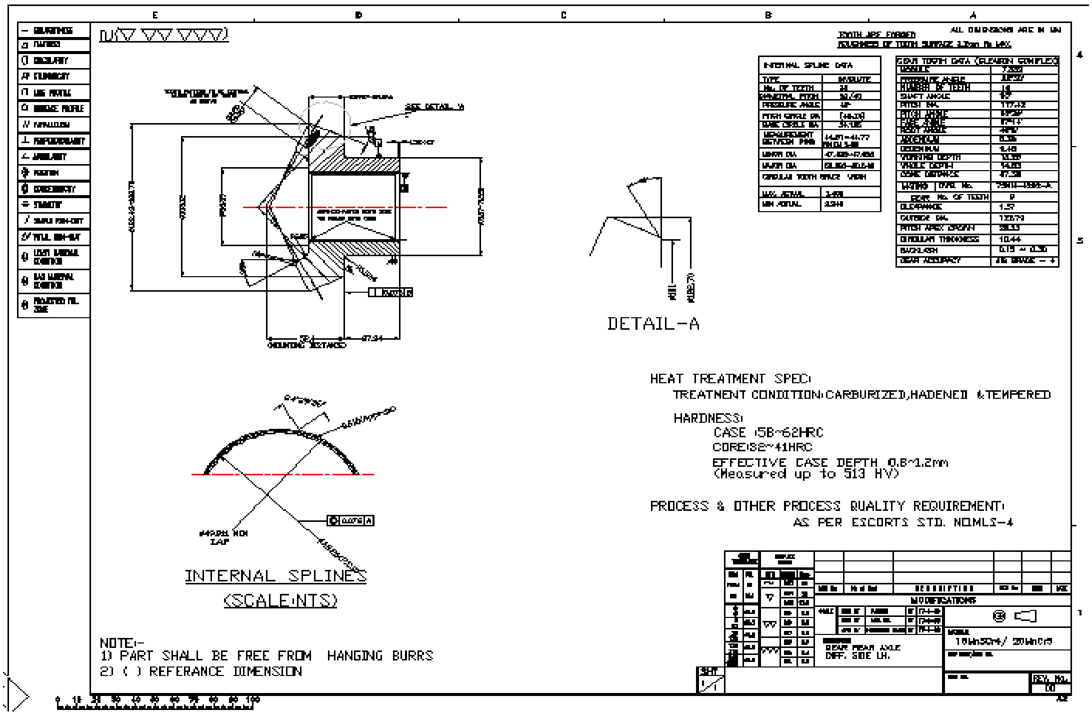

Figure 7 DRAWING OF SIDE GEAR LH

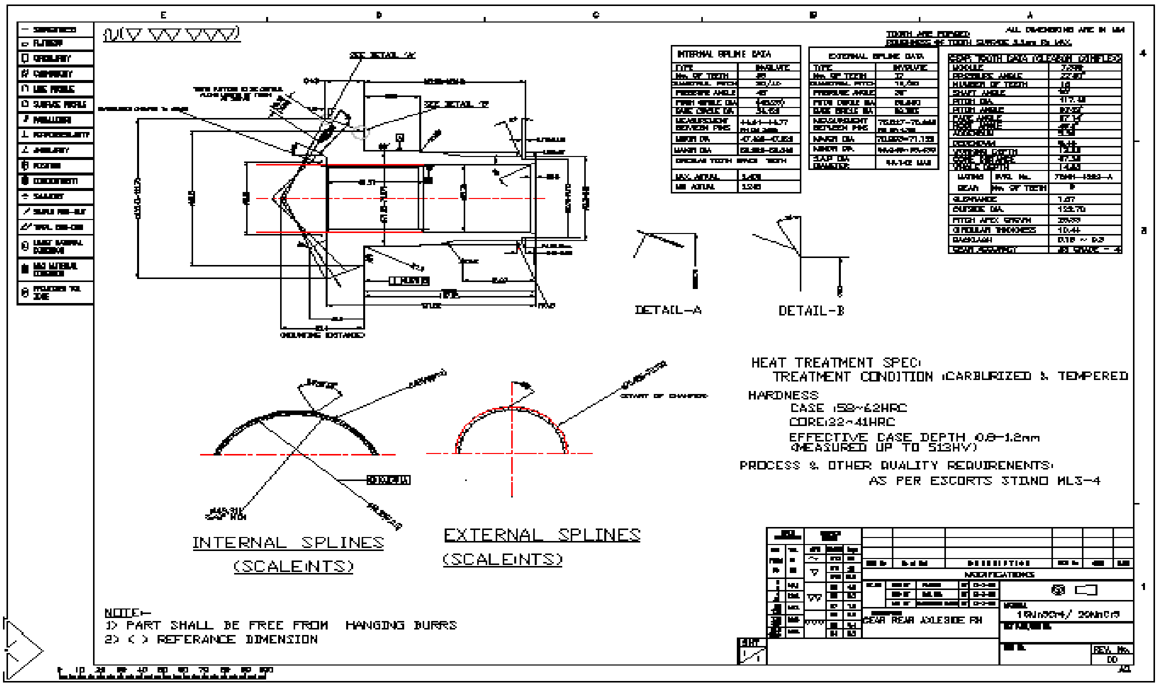

Figure 8 DRAWING OF SIDE GEAR RH

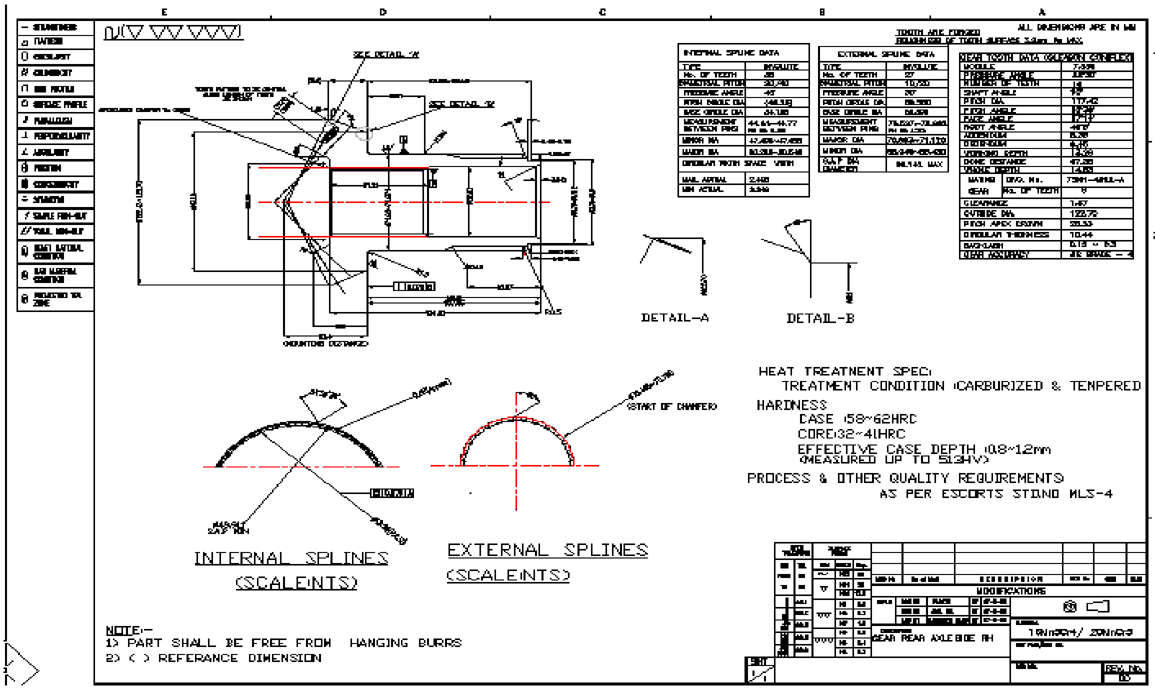

Figure 9 DRAWING OF PINION GEARS

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