Fabricating (Manufacturing) Spiral Bevel Gear With Using Cad/Cam And 5-Axis Cnc Machine

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ABSTRACT –The main application of spiral bevel gear (SBG) is in a vehicle differential where the drive direction from the drive shaft must be turned 90 degrees to drive the wheels. The production of SBG in the industries nowadays is mostly using the conventional 3-axis CNC machine. 3-axis CNC machine have limited angle of rotation that makes the fabricated SBG less precise and lower quality. The best solution to this problem is by using 5-axis CNC milling machine to produce the spiral bevel gear. CAD/CAM technology can help to produce it by using CNC machine. This research study involves to design the spiral bevel gear with 40 number of teeth and 3 module size. Moreover, the 3D model is created by using Solidworks software based on mathematical calculation. The G-code programming was generated by using MTS Topmill software for 5-axis CNC machine with face mill tool.

2. METHODOLOGY

In this experiment, SPINNER U-620 5-axis CNC machine and spiral bevel gear cutter was utilized to manufacture a spiral bevel gear because of its complex shape as shown in Fig. 1. Aluminum was selected as a spiral bevel gear material [2]. At first, the dimensional geometry of a spiral bevel gear material with 40 number of teeth and 3 module size was calculated by following equations[8]:

1. \[ m = \frac{D_2}{Z_2} \] (1)
2. \[ A_{OG} = \frac{0.5 D_2}{\sin \gamma} \] (2)
3. \[ A_{mG} = A_{OG} - 0.5F \] (3)
4. \[ \gamma' = 90^\circ - \gamma \] (4)
5. \[ P_{mg} = (\pi)(m) \left[ \frac{A_{mp}}{A_{op}} \right] \] (5)

13. \[ \delta_{dG} = \arctan \left( \frac{b_G}{A_{mg}} \right) \] (13)
14. \[ \delta_{dg} = \delta_{dp} \text{ pinion gear} \] (14)
15. \[ \theta_{FG} = \gamma + \delta_{dG} \] (15)
16. \[ \theta_{RG} = \gamma - \delta_{dG} \] (16)
17. \[ a_{OG} = a_G + 0.5F \tan \delta_{dp} \] (17)
18. \[ b_{OG} = b_G + 0.5F \tan \delta_{dG} \] (18)
19. \[ h_k = a_{op} + a_{OG} \] (19)
20. \[ h_l = a_{op} + b_{op} \] (20)
21. \[ \alpha_n = \frac{\alpha_{mp} + \alpha_{mg}}{2} \] (21)
22. \[ D_{OG} = D_2 + 2a_{OG} \cos \gamma \] (22)
23. \[ X_{G} = A_{oG} \cos \gamma - a_{op} \sin \gamma \] (23)

where \( m \) is module, \( D_2 \) is diameter of the gear, \( Z_2 \) is the number of teeth, \( A_{OG} \) is the outer circle diameter, \( A_{mG} \) is the minimum circle diameter, \( P_{mg} \) is the pitch circle diameter, \( \delta_{dG} \) is the distance from the gear center to the pinion gear, \( \alpha_n \) is the helix angle of the gear, \( D_{OG} \) is the distance from the gear center to the pinion gear, \( X_{G} \) is the distance from the gear center to the pinion gear.