Computer Aided Design of Cutting Tools

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Abstract- With today’s growing advancement, computer proves to be very powerful tool and extensively used for both engineering design and drafting purposes. One of the fundamental activities in which engineers involve is cutting tool design. The tool designers job has been simplified in resent years because of the advancement of the CAD technology. An attempt has been made to develop an interactive software in ‘C’ for designing and drafting of cutting tools, computation of machining parameters, force analysis and selection of materials for various cutting tools widely used in the industries with a great deal of accuracy.

INTRODUCTION

Computer aided design has been proved to be very useful in improving designers productivity and the best approach for meeting the recent critical design requirements. It speeds up the design activities, cater innovativeness in designs. Among the several fundamental reasons for implementing CAD system, enhancement in design process, improvement in quality of design, communication and database generation for manufacturing constitutes the major functions. The various design related tasks which are performed by a modern CAD system may be grouped into the various functional area like geometric modeling, engineering analysis, design review and evaluation, automated drafting etc.

The cutting tool is at the heart of any machining process. Designing of cutting tools is an iterative process and a very complex task performed by tool designer. The computer-aided design of cutting tools significantly reduces the time required for its design and drafting.

COMPUTER AIDED DESIGN OF CUTTING TOOLS

The program has been developed in “Turbo C”; for designing and drafting of various cutting tools viz, single point cutting tool, milling cutter, broach, drill & reamer. The software developed incorporates three modules namely designing, analysis and drafting. The methodology adopted can be visualized in flow charts. The database is created for tool dimensions, machine parameters, and work and tool material properties. The analysis module computes the various forces and bending moments. The design module determines the various tool geometry parameters. These parameters are further utilized by drafting module in which the tool profiles are generated. Since, the program has modular structure, it can be executed for the selected tool option. It accepts the input values in permissible extents and output is generated after executing the relevant program module.

FLOW CHARTS AND OUTPUT GENERATED
FLOWCHART 1. Single Point Cutting Tool

START

READ Data

Selection of "X", "H", "L", "N", "F", "G" & "I"

IF "X" = 0 THEN "BACK"

END

Shank Point Cutting Tool:

br - back rake angle
sr - side rake angle
ara - side relief angle
ear - end relief angle
sce - side cutting edge angle
ece - end cutting edge angle
sr - nose radius
cs - cutting speed
dwp - diameter of workpiece
N - revolution per minute
fr - feed rate
dc - depth of cut
E - modulus of elasticity
dwp - diameter of workpiece after one pass
Rmr - rate of metal removal
ls - specific energy
Fc - cutting force
Cf - cutting frequency
nf - natural frequency
da - deflection in tool
sb - stress in tool
B - width of shank
H - height of shank
Ohl - overhang length

DESIGN OF SINGLE POINT CUTTING TOOL

TOOL MATERIAL = A.S.S.
WORK MATERIAL

1. ALLOY STEEL
2. CAST IRON
3. STAINLESS STEEL
4. ALUMINIUM ALLOY
5. EXIT

ENTER YOUR CHOICE = 1

INPUT VALUES

ENTER VALUE OF DIA. OF WORKPIECE = 30

ENTER VALUE OF DIA. OF WORKPIECE AFTER ONE PASS = 28

DESIGN OF SINGLE POINT CUTTING TOOL

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutting speed</td>
<td>540 rpm</td>
</tr>
<tr>
<td>Rate of metal removal</td>
<td>489.00 mm/min</td>
</tr>
<tr>
<td>Modules of elasticity</td>
<td>10699.00 kaf/cm²</td>
</tr>
<tr>
<td>Cutting force</td>
<td>818.6 mm/sec</td>
</tr>
<tr>
<td>Natural frequency</td>
<td>41.5 cycle/sec</td>
</tr>
<tr>
<td>Deflection of tool</td>
<td>0.01 mm</td>
</tr>
</tbody>
</table>

DESIGN OF SINGLE POINT CUTTING TOOL

back rake angle = 20°
side rake angle = 20°
side relief angle = 6°
side cutting edge angle = 15°
nose radius = 1.5 mm

REM: DESIGN IS SAFE
INPUT VALUES OF PLAIN MILLING CUTTERS

SPEED OF ARBOUR (RANGE 25-40 n/min) = 30
OUTSIDE DIA OF ARBOUR = 25
HELIIX ANGLE OF MILLING CUTTER = 30
DEPTH OF CUT = 5
WIDTH OF WORK PIECE = 35

DESIGN OF PLAIN MILLING CUTTER

MAKING ANGLE CLEARANCE ANGLE TOOTH ANGLE CLEARANCE ANGLE FEET PER TOOTH OUTER DIAMETER OF CUTTER CUTTER RADIUS NO. OF TEETH FEET RATE CIRCULAR PITCH CUTTER WIDTH TOOTH HEIGHT BODY THICKNESS FEET RATE PROXIMAL REMOVAL RATE LENGTH OF ARBOUR

14 deg 10 deg 8 deg 5 deg 2 deg 50.5 mm 44.44 mm 4.88 mm 12.50 mm 7.50 mm 250.00 mm

FORCE ANALYSIS IN MILLING

tangential force = 114,700 kgf
power consumed in milling = 0.56 kw
"calculated arbour dia" = 22.69 mm
power required at spindle = 0.81 kw

REMARK: DESIGN IS SAFE
**Breach:**

- diameter of basic hole
- length of hole to be broach
- feed per tooth
- broaching allowance
- pitch of teeth
- maximum number of teeth in contact
- number of cutting teeth
- number of sizing teeth
- diameter of front pilot
- length of cutting tool
- diameter of rear pilot
- length of sizing teeth
- length of threaded portion
- total length of shank
- total length of broach
- cutting force in broaching
- permissible pulling force in broaching
- area of critical cross section.

**Flowchart 4.0**

**Design of Twisted Drill**

**Tool Material** = H.S.S.

**Work Material** = Mild Steel

**DIA of hole to be drilled** = 13

**Cutting Speed** = 5

**Hole Length to be Drilled** = 25

**Length of Travel Req. Before Drilling Full Dia.** = 5

**Enter Feed Rate (Range 0.175-0.575)** = 0.254

**Output Parameters**

- Feed per revolution = 0.06 mm/100 mm length of drill
- Chip thickness = 0.11 mm
- Web thickness = 0.12 mm
- Land length = 4.2 mm
- Margin = 0.76 mm

**Force Analysis for Drill**

- Thrust force = 214.63 kN
- Thrust due to chisel edge = 89.22 kN
- Total torque = 304.12 kN.m
- Axial force = 314.72 kN
- Drilling power = 0.12 kW
- Drilling thrust = 257.35 kN

**Remark:** Design is safe

**Machinability concept for twist drills.**
CONCLUSIONS

Performance results along with the drawings for the variety of cutting tool parameters can be obtained for comparison purpose. Looking into the matter, constraints, tool and work materials availability etc., a best decision can be taken to finalize the design of cutting tools for maximum efficiency and safe design. There is a lot of scope to further extend the program for different tools and work materials, machining conditions etc.

REFERENCES