Crank and Slotted Lever Quick-Return Mechanism

Cutting and return crank angles, time ratio, ram stroke and mean cutting speed of a crank and slotted lever quick-return mechanism of a shaper.

Method: Crank and slotted lever kinematics

Input parameters

Unit system: SI

Parameter	Value	Unit
Crank radius	120.00	mm
Distance between crank centre and lever pivot	300.00	mm
Slotted lever length (pivot to ram connection)	750.00	mm
Crank speed	30.000	rpm

Calculated results

Parameter	Value	Unit
Crank angle of the cutting stroke	227.16	°
Crank angle of the return stroke	132.84	°
Time ratio (cutting/return)	1.7100	
Ram stroke	600.00	mm
Mean cutting speed	28.527	m/min

Notes for this case

• The slotted lever reaches its extreme positions when the crank is perpendicular to it, which happens at crank angles ±arccos(r/d) either side of the line of centres. The crank therefore turns through α = 2 arccos(r/d) on the return stroke and 360° − α on the cutting stroke, so the ram returns faster in the ratio (360° − α)/α. The lever swings ± arcsin(r/d), giving a ram stroke of about 2lr/d. Mean cutting speed is the stroke over the cutting time (360° − α)/ω.

Formula and method

$$\alpha = 2\arccos\frac{r}{d}, \quad \frac{t_c}{t_r} = \frac{2\pi - \alpha}{\alpha}, \quad S = \frac{2lr}{d}$$

Variables

r	Crank radius	m
d	Distance between crank centre and lever pivot	m
l	Slotted lever length (pivot to ram connection)	m
N	Crank speed	rad/s
β	Crank angle of the cutting stroke	rad
α	Crank angle of the return stroke	rad
t_c/t_r	Time ratio (cutting/return)	-
S	Ram stroke	m
$\bar{v}_c$	Mean cutting speed	m/s

Method and standards

Quick return.

Assumptions and limits

- Rigid links; ram moves in line with the lever tip's chord.

References

Crank and slotted lever kinematics

Report details

Report reference	FCC-WH6T-GE67 (the same inputs always give the same reference)
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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/mechanical/statics-dynamics/quick-return-mechanism

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.