ABAQUS Tutorial – Hot Forge

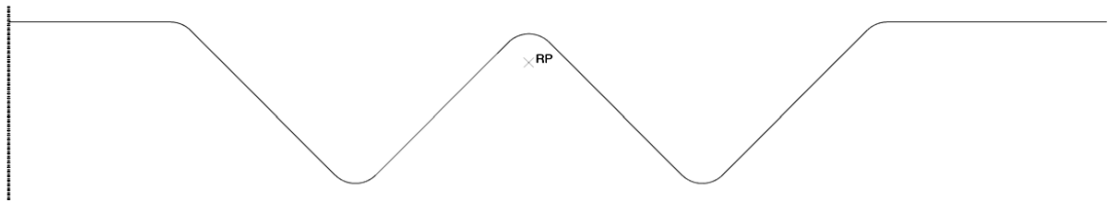
Consider a axisymmetric Block with a 150mm Radius & 80mm Height which is going to be Hot Forged with initial temperature 800°C.The upper die Temperature is 50°C and the Lower ground temperature is 200°C. Determine the maximum force needed for this operation and the final shape of the Block.

Finite Element Solution (ABAQUS)

Start => Programs => ABAQUS 6.8-1 => ABAQUS CAE
Select 'Create Model Database'
File => Save As => create directory for files

Module: Part

Part => Create => Name: Block, select Axisymmetric, Deformable, Shell, Approx size 0.4 => Continue.
Add => Line => Rectangle => enter coordinates (0,0),(0.15,0.08) then right click => Cancel Procedure => Done.
Part => Create => Name: Die, select Axisymmetric, Analytical rigid, Approx size 0.5 => Continue.
Add => Line => Connected Lines => enter coordinates (0,0.03), (0.03,0.03), (0.06,0), (0.09,0.03), (0.12,0), (0.15,0.03), (0.19,0.03) then right click => Cancel Procedure.
Add => Fillet => Fillet radius: 0.005 => Fillet all Connected Lines. => Cancel Procedure => Done.
Tools => Reference Point => Select a Point from the 'Die'



Module: Property

Material => Create => Name: Steel ,General, Density => set Mass Density = 7800 , Mechanical, Elasticity, Elastic => turn on 'Use temperature-dependent data' => insert the table below:

#	Young's Modulus	Poisson's Ratio	Temp
1	1.8e9	0.3	800
2	1.5e9	0.3	1100

Mechanical, Plasticity, Plastic => turn on 'Strain-Rate-dependent data' & 'Use temperature-dependent data' => insert the table below:

#	Yield Stress	Plastic Strain	Rate	Temp
1	2.90E+07	0	0	800
2	3.00E+07	0	0.02	800
3	6.00E+07	0.05	0.02	800
4	7.50E+07	0.2	0.02	800
5	7.00E+07	0.4	0.02	800
6	4.00E+07	0	0.1	800
7	8.50E+07	0.05	0.1	800
8	1.00E+08	0.1	0.1	800
9	1.10E+08	0.4	0.1	800
10	4.50E+07	0	1	800
11	8.00E+07	0.05	1	800
12	1.10E+08	0.1	1	800
13	1.30E+08	0.4	1	800
14	9.00E+06	0	0	1100
15	1.00E+07	0	0.02	1100
16	3.00E+07	0.1	0.02	1100
17	3.50E+07	0.2	0.02	1100
18	2.00E+07	0	0.1	1100
19	3.50E+07	0.1	0.1	1100
20	4.50E+07	0.3	0.1	1100
21	3.30E+07	0	1	1100
22	6.00E+07	0.1	1	1100
23	7.50E+07	0.2	1	1100
24	8.00E+07	0.3	1	1100
25	7.00E+07	0.6	1	1100

Thermal, Conductivity => set Conductivity = 470

Thermal, Specific Heat => set Specific Heat = 50

Thermal, Inelastic Heat Fraction => set Fraction = 0.9 => OK.

Section => Create => Name: Steel Section, Solid, Homogeneous => OK.

Assign => Section => select Block by clicking on it => Done => OK.

Module: Assembly

Instance => Create => select 'Block' from part list, select ' Independent (mesh on instance) '=> Apply => select 'Die' from part list, select 'Independent (mesh on instance)' , select 'Auto offset from other instances' => OK.

Tools => Partition => Edge => select ‘Enter Parameter’ => Select the right-side of the top edge of the Block => Done =>Enter 0.8 as the ‘Normalized edge parameter’ value => Create Partition => Done.

Instance => Translate => select the ‘Die’ => select the point on the ‘Die’ => select the point on the Block => OK.

Module: Step

Step => Create => Name: Forging, ‘Dynamic, Temp-disp, Explicit’ => Continue => Description: Forging Block, Time Period: 0.02, Nlgeom: On => OK.

Tools => Set => Create => Name: DIE REF => Continue => select reference point of Die => Done

Tools => Set => Create => Name: BOT => Continue => select bottom edge of the Block => Done

Tools => Set => Create => Name: TOP => Continue => hold SHIFT & select two edges at the top of the Block => Done

Tools => Set => Create => Name: RIGHT => Continue => select right edge of the Block => Done

Tools => Set => Create => Name: LEFT => Continue => select left edge of the Block => Done

Tools => Set => Create => Name: BLOCK => Continue => select the Block => Done

Tools => Surface => Create => Name: RSURF => Continue => select right edge of the Block => Done

Tools => Surface => Create => Name: DSURF => Continue => select the Die => Done

Tools => Surface => Create => Name: RSURF => Continue => select right edge of the Block => Done => Select the color which the Die have contact with the block on that side.

Tools => Surface => Create => Name: TRSURF => Continue => hold SHIFT & select edges on the right and top side of the Block => Done

Module: Interaction

Interaction => Property => Create => Name: FRICHEAT, Type: Contact => Continue => Mechanical, Tangential Behavior =>set Friction formulation: Penalty => set Friction Coeff = 0.5

Thermal, Thermal Conductance => insert the table below:

Conductivity	Clearance
1000	0
0	0.0001

=>OK.

Interaction => Create => Name: CONVEC, Step: Forging, types for selected step: Surface film Condition => Continue => Surfaces => select RSURF => Continue => set Film Coefficient = 2000, Sink temperature = 30 => OK.

Interaction => Create => Name: RRAD, Step: Forging, types for selected step: Surface radiation => Continue => Surfaces => select RSURF => Continue => set Emissivity = 0.8, Ambient temperature = 30 => OK.

Special => Inertia => Create => Name: RIEHC, Type: Heat Capacitance => Continue => select REF DIE => Continue => set Capacitance = 4e5 => OK.

Model => Edit Attributes => Model-1 => set Absolute zero temperature = -273.15, Stefan-Boltzman constant = 5.66e-8

Module: Load

Tools => Amplitude => Create => Name: DIEAMP, Type: Smooth step => Continue => insert table below:

#	Time/Frequency	Amplitude
1	0	0
2	0.02	1

BC => Create => Name: DIEMOVE, Step: Forging, Type: Mechanical, Types for selected Step: Displacement/Rotation=> Continue => select REF DIE => Continue => set U2 = -0.05, Amplitude = DIEAMP

BC => Create => Name: DIEFIX, Step: Initial, Type: Mechanical, Types for selected Step: Displacement/Rotation=> Continue => select REF DIE => Continue => select U1, UR3

BC => Create => Name: BSYM, Step: Initial, Type: Mechanical, Types for selected Step: Displacement/Rotation => Continue => select BOT => Continue => select U2, UR3

BC => Create => Name: BTEMP, Step: Forging, Type: other, Types for selected Step: Temperature => Continue => select BOT => Continue => set magnitude = 200

BC => Create => Name: LSYM, Step: Initial, Type: Mechanical, Types for selected Step: Displacement/Rotation => Continue => select LEFT => Continue => select U1, UR3

Predefined Field => Create => Name: ITEMP, Step: Initial, Type: other, Types for selected Step: Temperature => Continue => select Block => Continue => set magnitude = 800

Module: Mesh

Mesh => Element Type => select Block => Continue => set Element Library: Explicit, Family: Coupled Temprature-Displacement, Element Controls: Hourglass control: Stiffness => OK => Dissmis

Mesh => Controls => select the Block => Done => set Element Shape: Quad, Technique: Structured, Algorithm Options: Minimize the mesh transition

Seed => Instance => select the Block => Done => set Approximate global size = 0.003 => OK.

Mesh => Instance => select the Block => Done

Module: Job

Job => Create => Forging => OK

Job => Manager => Submit