



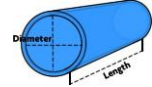
PLATE ROLLING

PROCESS METALLURGY

- 060110324 Boğaçhan SOLAK
- 060110312 Büşra KESOĞLU
- 060110334 Cihan ÇETINKAYA
- 060110306 Duygu ERGİN
- 060110337 Damla KORKMAZ
- 060120432 Görkem ÖZTÜRK
- 060110311 Gökcü VURAL
- 060100408 Tolga KARAAARSLAN
- 060110438 Tuncay ÇAKMAK



- Thicknesses of 10 to 50 mm
- Widths in excess of 2 m and up to 5 m
- Length of 4 m to 30 m



Objectives

- To achieve the correct dimensions
- To achieve the correct mechanical properties



Features

Plates are:

- Strong
- Withstand high loads
- Enduring impacts and pressures
- Highly durable



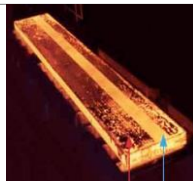
Reheat Furnace

- Heat temperature: 1150-1270 C
- The deformation strength of steel is reduced
- Furnace is fired by gas burners



Descaling

- Oxide layer on the outer surfaces of the slab is removed
- High pressure water sprays are used to remove it



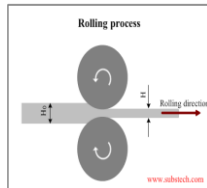
Rolling

- Plate mill stands are usually 4-high design.
- They are largest type of rolling mill.
- All plate mills are of the reversing type.



Rolling Process

- Rolling is carried out in two stock orientations.
- The plate is roadsided and turned trough 90° to rolled
- Presizing is used before broadsizing



Accelerated Cooling



Once the required dimensions and thickness has been reached in the mill, the plate undergoes cooling. For many steel grades and applications, the cooling path is as influential in the plates' metallurgical development as is the strain path in the mill. Systems for this purpose of controlled cooling are known as accelerated cooling systems, and are designed to reduce the plate temperature at high rates, down to a level at which all microstructural transformations are complete.

Cooling Beds



Whether or not accelerated cooling is applied, plates are finally air-cooled as they are transferred across a cooling bed. In special cases, stacking of plates to reduce the cooling rate is employed. This is to allow hydrogen to diffuse out of the plate, thereby reducing its embrittling effect in service.

Finishing Process: Shearing

Purposes;

- Cutting plates to desired size
- Removing edge and end material which deviates from the required properties
- Extracting test samples

Shearing

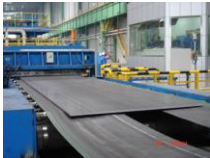


Finishing Process: Levelling

Purposes;

- Surface smoothing
- Stress relieving

Shearing and Levelling



Testing

Mechanical Expansion

- The final diameter and straightness of the pipe is obtained.
- This corrects any deformations.

Hydrostatic Testing

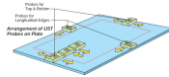
- All pipes are subjected to automatic hydrostatic testing after mechanical expansion.



Nondestructive Examinations

Automatic Plate UST

- > The entire surface of each plate is scanned by multi channel UST with a self sensitivity assurance system and a self calibration function.
- > Plate edges are carefully checked by double-probe mechanism.



Automatic UST of Welds

- > Welds are ultrasonically tested by multi-channel UST.



Nondestructive Examinations

X-Ray Fluoroscopy



X-Ray Radiography



Full length of the radiographic examination system (2000/100)

PLATE
ROLLING
SIMULATION



Order Item		
Transition piece		
Thickness	mm	25
Top diameter	mm	4000
Bottom diameter	mm	4000
Height	mm	4000
Specification	S355G10+M	
Yield stress (Rp)	MPa	≥355
UTS (Rm)	MPa	470-630
Elongation (Rp)	%	≥22
ITT (Rp)	MPa	-70

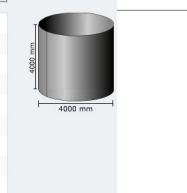


Plate Dimensions & Allowances

Cut Plate Dimensions

Thickness: 25 mm

Width: mm

Length: mm

Allowances

Edge trim (each side): mm

End trim (each end): mm

Test crop (one end): 400 mm

Slab Chemistry & Rolling Options

Rolling mode: As rolled TMCR

Hold ratio:

Hold thickness: 15.00 mm

Slab Chemistry

	A	B	C	D	E	F
Cost \$t	620	560	630	630	540	640
C	0.05	0.15	0.10	0.11	0.15	0.08
Mn	1.40	1.40	0.75	1.15	0.75	1.50
Si	0.20	0.40	0.25	0.45	0.25	0.35
P	0.007	0.010	0.010	0.012	0.010	0.007
S	0.001	0.008	0.010	0.008	0.010	0.001
Nb	0.020			0.25		0.20
Ni	0.020	0.026		0.35		0.22
Ti	0.010					0.010
Cr				0.55		
Cu				0.30		
N	0.005	0.007	0.008		0.008	0.006
Al	0.030	0.030		0.030		0.030

Slab Build-up

Cut Plate Dimensions

Thickness: 25mm

Width: 1000mm

Length: 1000mm

Allowances

Edge trim: 100mm

End trim: 300mm

Test crop: 400mm

Plates per slab:

Width mm:

Thickness mm:

Length mm:

Mass t: 11.373

Thickness reduction: 12.200

Width increase ratio: 0.832

Slabs:

Plates: 25 1 1

Plate view:

Summary

Slab Chemistry

Slab grade: A

Slab cost per tonne: \$620

Element	Result
C	0.05
Mn	1.40
Si	0.20
P	0.007
S	0.001
Ni	0.020
Nb	0.020
Ti	0.010
Cr	
Cu	
N	0.005
Al	0.030

Cut Plate Dimensions

Thickness: 25 mm

Width: 1000 mm

Length: 1000 mm

Allowances

Edge trim: 100 mm

End trim: 300 mm

Test crop: 400 mm

Rolling Options

Rolling mode: TM

Hold ratio: 2.2:1

Mother plate dimensions: 25x1200x48292 mm

Slab Build-up

25 Slabs: 305x1900x2500 mm

Total mass: 284.317 t

Total slab cost: \$176277

	Thickness mm	Temperature °C	No. of passes	Time s
Slab	305	1200		
Roughing phase			11	103
Turn	131.68	1150		
Heating phase			3	319
End of hold	55.00000000000001	850		
Cooling phase			3	30
Mother plate	25	810		
Total			19	482

Thickness / mm

Time / s

START ROLLING

Settings summary

Element	Result
C	0.06
Mn	1.40
Si	0.20
P	0.007
S	0.001
Ni	
Nb	0.020
Ti	0.010
Cr	
Cu	
N	0.005
Al	0.030

Slab Chemistry	Cut Plate Dimensions
Slab grade A	Thickness: 25 mm
Slab cost per tonne \$520	Width: 1000 mm
	Length: 1000 mm

Allowances	Rolling Options
Edge trim: 100 mm	Rolling mode: TM
End trim: 300 mm	Hold ratio: 2.2:1
Test crop: 400 mm	Mother plate dimensions: 25x1200x48292 mm

Slab Build-up
25 Slabs: 305x1900x2500 mm
Total mass: 284.317 t
Total slab cost: \$176277

	Thickness mm	Temperature °C	No. of passes	Time s
Slab	305	1200		
Roughing phase			11	103
Turn	131.68	1150		
Heating phase			3	319
End of hold	55.00000000000001	850		
Cooling phase			3	30
Mother plate	25	810		
Total			19	482

Thickness / mm

Time / s

Test House Report

	Result	Min	Max	Rolling mode	TM
Yield stress, Re / MPa	401	305		Hold ratio	2.2:1
UTS, Rm / MPa	470	470	630	End Hold Temperature / °C	880
% Elongation	31	22		Finish Rolling Temperature / °C	820
ITT / °C	-74	-70			

Production Report

	Result	Total	Unit cost	Total Cost	Achieved	Planned
Mass (t)	22.745	284.317	\$620 /tonne	\$176277	# Mother plate	2
Total rolling time (s)	600	7813	\$ 60000 /hour	\$126875	Throughput (tph)	134.455 (55.9%)
Total				\$303152	# Cut plates	2

Order Item

Transition piece

Thickness	mm	25
Top diameter	mm	4000
Bottom diameter	mm	4000
Height	mm	4000
Specification	S355G10+M	
Yield stress (Rp)	MPa	≥355
UTS (Rm)	MPa	470-630
Elongation (Rp)	%	≥22
ITT (Rp)	MPa	-70

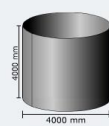


Plate Dimensions & Allowances

Cut Plate Dimensions

Thickness: 25 mm

Width: 2000 mm

Length: 1000 mm

Allowances

Edge trim (each side): 100 mm

End trim (each end): 300 mm

Test crisp (one end): 400 mm

Slab Chemistry & Rolling Options

Rolling mode: As rolled, TMCr

Hold ratio: 2.2

Hold thickness: 55.00 mm

Slab Chemistry

	A	B	C	D	E	F
Coef M	0.20	0.50	0.30	0.30	0.40	0.40
C	0.08	0.15	0.10	0.11	0.15	0.08
Mn	1.40	1.40	0.75	1.15	0.75	1.50
Si	0.25	0.40	0.25	0.45	0.25	0.35
P	0.007	0.010	0.015	0.012	0.018	0.007
S	0.001	0.008	0.012	0.008	0.012	0.001
Nb				0.25		
Al	0.005	0.028		0.25		0.22
Ti	0.010					0.015
Cr				0.50		
Cu				0.30		
N	0.005	0.007	0.008	0.008	0.008	0.008
As	0.030	0.030		0.030		0.035

Slab Build-up

Cut Plate Dimensions
 Thickness 25mm
 Width 2000mm
 Length 1000mm

Allowances
 Edge trim 100mm
 End trim 300mm
 Test crop 400mm

Plates per slab: 5 (Width), 5 (Thickness), 5 (Length)

Width mm: 1900, 1900, 1900

Thickness mm: 300, 300, 300

Length mm: 2500, 2500, 2500

Mass t: 11.373, 11.373, 11.373

Thickness reduction: 12.200, 12.200, 12.200

Width increase ratio: 1.158, 1.158, 1.158

Slabs: 2, 2, 2

Plates: 10, 10, 10

Summary

Slab Chemistry
 Slab grade A
 Slab cost per tonne \$620

Element	Result
C	0.06
Mn	1.40
Si	0.20
P	0.007
S	0.001
Ni	
Nb	0.020
Ti	0.010
Cr	
Cu	
N	0.005
Al	0.030

Cut Plate Dimensions
 Thickness: 25 mm
 Width: 2000 mm
 Length: 1000 mm

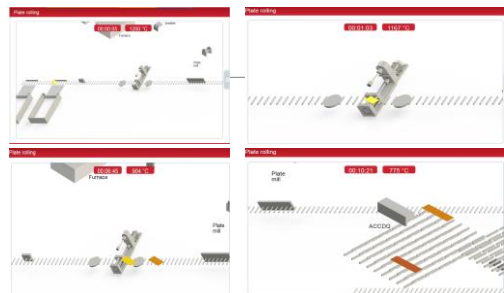
Allowances
 Edge trim: 100 mm
 End trim: 300 mm
 Test crop: 400 mm

Rolling Options
 Rolling mode: TM
 Hold ratio: 2:2:1
 Mother plate dimensions: 25x2200x26341 mm

Slab Build-Up
 2 Slabs: 305x1900x2500 mm
 2 Slabs: 305x1900x2500 mm

Total mass: 68.236 t
 Total slab cost: \$42306

	Thickness mm	Temperature °C	No. of passes	Time s
Slab	305	1200		
Roughing phase			11	103
Turn	131.68	1150		
Finishing phase			3	379
End of hold	55.00000000000001	850		
Finishing phase			3	30
Mother plate	25	810		
Total			19	482



Settings summary

Element	Result
C	0.06
Mn	1.40
Si	0.20
P	0.007
S	0.001
Nb	
Nb	0.020
Ti	0.010
Cr	
Ca	
N	0.005
Al	0.030

Allowances
Edge trim: 100 mm
End trim: 300 mm
Test crop: 400 mm

Rolling Options
Rolling mode: TM
Hold ratio: 2.2:1
Mother plate dimensions: 25x2200x26341 mm

Slab Build-up
2 Slabs: 305x1900x2500 mm
2 Slabs: 305x1900x2500 mm
2 Slabs: 305x1900x2500 mm

Total mass: 68.236 t
Total slab cost: \$42306

	Thickness mm	Temperature °C	No. of passes	Time s
Slab	305	1200		
Roughing phase			11	103
Turn	121.68	1150		
Heading phase				319
End of hold	55.00000000000001	850		
Finishing phase			4	90
Mother plate	25	810		
Total			19	482

Test House Report

	Result	Min	Max
Yield stress, Re / MPa	408	355	
UTS, Rm / MPa	474	470	530
% Elongation	30	22	
ITT / °C	-73	-70	

Rolling mode	TM
Hold ratio	2.2:1
End Hold Temperature / °C	853
Finish Rolling Temperature / °C	813

Production Report

	Result	Total	Unit cost	Total Cost	Achieved	Planned
Mass / t	22.745	68.236	\$620 / tonne	\$42306	# Mother plate: 2	
Total rolling time / s	617	7713	\$ 66000 / hour	\$128542	Throughput / tph: 132.712 (54.2%)	244.640
Total			\$170846		# Cut plates: 2	

THANK YOU FOR
LISTENING!

