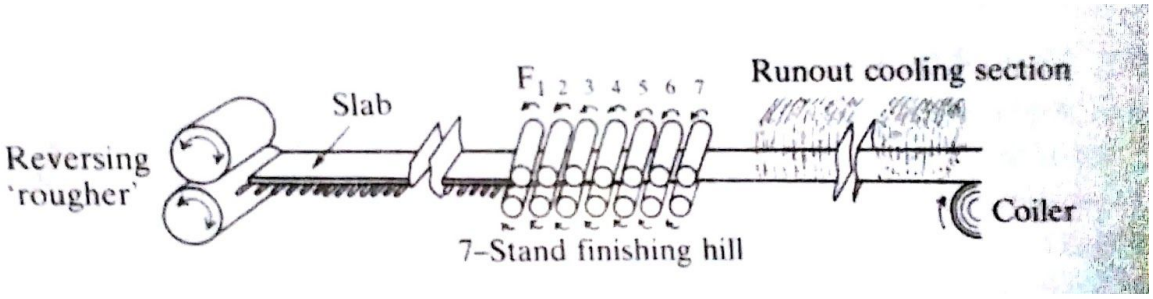
Problem Statement for Core Case Study

A hot rolling mill superintendent considered the possibility of increasing his mills tonnage capacity by increasing the heights of the ingots charged to the soaking pits. Following the soaking operation, these ingots are rolled down to 32-mm-thick slabs in the rougher stand, exit at 1590 K and then pass along an entry (or holding) table into the finishing stands. Slab temperature run down during this period is an important constraint on the finishing operation; in order to avoid overloading the electric motors running the finishing stand, the slab temperature must never drop below 1422 K on entry into stand F (see figure):



Assuming the critical conditions of a minimum lag of 5s between each slab and a cooling speed of 20m/s on 2.3mm gauge material, calculate the maximum height of ingot that could be handled by the operation and the new theoretical annual mill capacity (i.e. tonnes/annum on a 24 hour basis of operation with no shut-downs producing 2.3 mm gauge material).

Data:

Density of slab (transfer bar)	7450 kg/m^3
Thickness of slab	32 mm
Temperature of slab at rougher	1590 K
Minimum temperature of slab entering finishing stands	1422 K
Ingot thickness	0.61 m
Width of ingot	1.21 m
Heat capacity of slab	0.45 kJ kg^{-1} K^{-1}

Thickness of strip	2.3 mm
Coiling speed (speed of strip)	20 ms^{-1}
View factor of slab ($F_{slab\ /\ \infty}$)	1
Emissivity of slab	0.8
Stefan-Boltzmann constant	$5.67 * 10^{-8}$ W m^{-2} K^{-4}

For the purposes of this calculation, ignore temperature gradients across the slab, natural convection from the slab surfaces, conduction into rollers and finally, back-radiation from the plant.