

LECTURE 6: WATER HAMMER

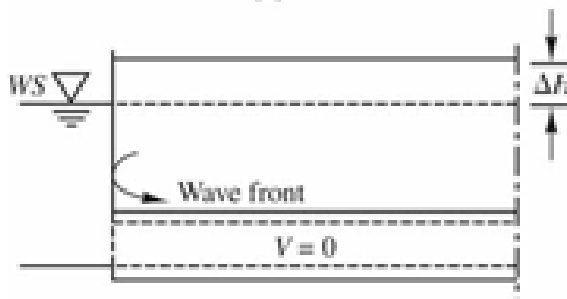
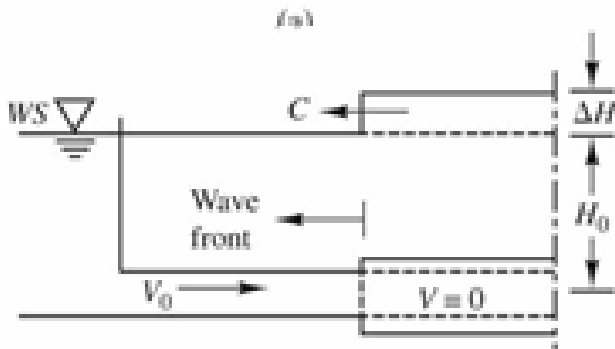
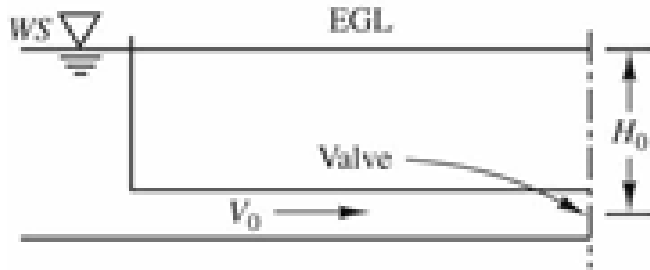
Assist. Prof. Neslihan SEMERCI

Marmara University

Department of Environmental Engineering

WATER HAMMER

Valve closure:

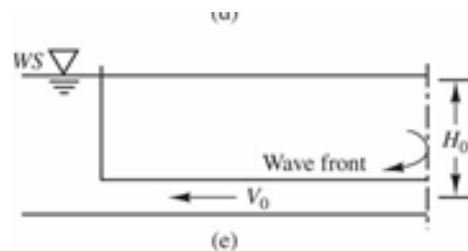
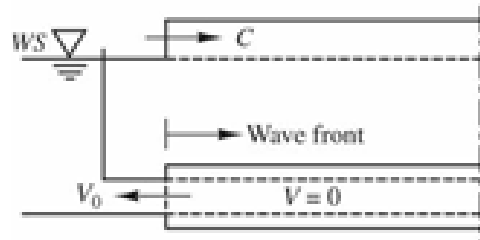
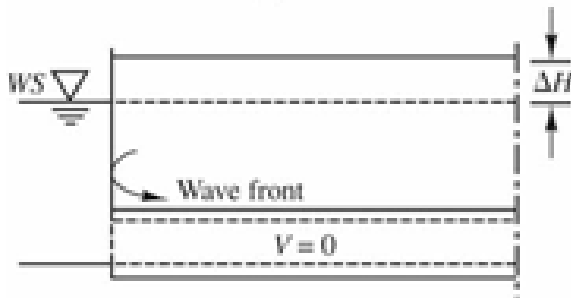


$$t=L/C$$

- Water in close proximity to the valve is brought to rest.
- Sudden change of velocity in the water mass cause a local pressure increase, DP
- Water column is compressed and the pipe walls expands slightly.
- Both compression and expansion help provide a little extra volume, allowing water enter the section continuously until it comes to a complete stop.
- A wave of increased pressure propagates up the pipe toward reservoir, the entire pipe is expanded and the water column within is compressed by the increased pressure.
- The entire water column within the pipe comes to a complete halt. ($V=0$)

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2nd period (EGL in the pipe > EGL in reservoir)



$$t=2L/C$$

- The halted water in the pipe flows back into the reservoir as soon as the pressure wave reached the reservoir.
- Decreased pressure wave travels downstream toward the valve.
- During this period water behind the wave front moves in the upstream direction as soon as the column decompresses.
- By the time, decreased pressure wave arrives at the valve, the entire water column of water within the pipe is in motion in the upstream direction.
- Pressure at the valve to drop below the normal static pressure.

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3rd osciallation period (Pressure at the valve < normal static pressure)

This period begins as a wave of negative pressure propagates up the pipe toward reservoir.

As the instant negative pressure reaches the reservoir the water column within the pipe again comes to a complete standstill.

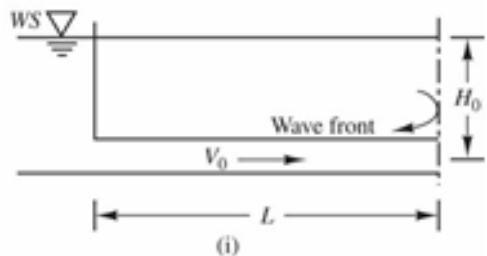
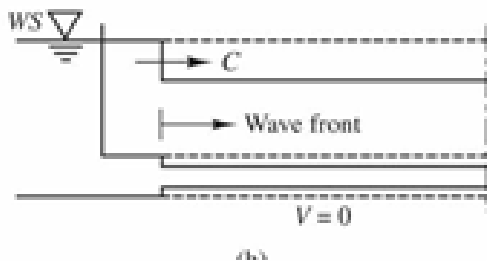
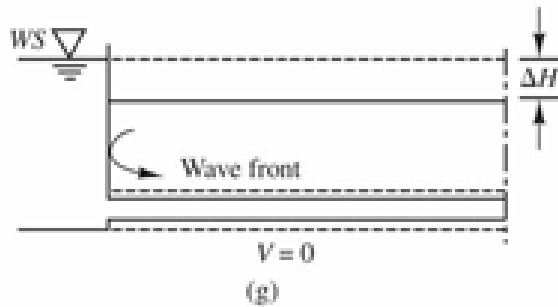
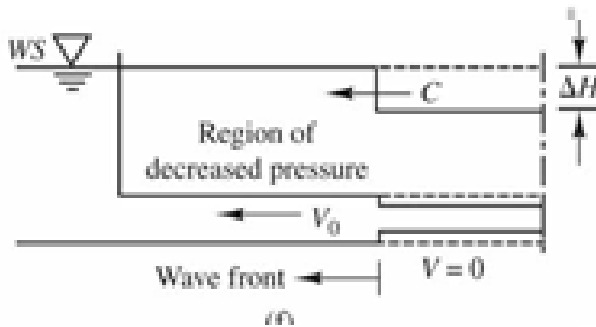
EGL of the reservoir > EGL of the pipe → water flows into the pipe

4th osciallation period (Pressure at the valve < normal static pressure)

This period is marked by a wave of normal static pressure moving downstream toward the valve.

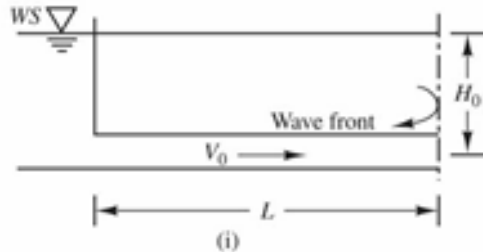
The water mass behind the wave front also moves in the downstream direction.

As the pressure wave arrives the valve, the entire pipe returns to original EGL and water is moving downstream.



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4th oscillation period-continue (Pressure at the valve < normal static pressure)



- For an instant the conditions throughout the pipe are somewhat similar to the conditions at the time of valve closure except the water velocity.
- Water velocity has been reduced because of the energy losses.
- Another cycle starts
- Four sequential waves travels up & down the pipe in exactly the same manner as the first cycle .
- Pressure waves are smaller in magnitude.
- Pressure-wave oscillations continues until finally the waves die out completely.