CHAPTER 5

CONCLUSIONS

5.1 SUMMARY

From our discussion on the control of ribs on the base pressure and wall pressure distribution of suddenly expanded subsonic, sonic and supersonic flows, it can be concluded that,

- The base pressure is strongly influenced by the flow Mach number, level of expansion at the nozzle exit and the length-to-diameter ratio of the enlarged duct, in the absence of rib.

- For the enlarged duct without rib, the minimum L/D required for subsonic and correctly and underexpanded sonic flows, to reattach and develop is L/D = 4.

- For Mach 1.6 flow also, recirculation intensifies resulting in progressively reduced base pressures only for L/D ratios more than 4, for no rib case.

- With the rib is placed in the enlarged duct, for subsonic and sonic flows, there is either a decrease in base pressure or negligible increase in base pressure compared to the uncontrolled case till NPR 3. For NPRs above 4 the base pressure increases with increase of NPR. Also, the base pressure increases with increasing rib aspect ratio for NPR above 4.
• For Mach 1.6 flow with rib, except for L/D = 2 (showing absence of any reattachment and reverse flow), the base pressure marginally increases or slightly decreases for overexpanded states (NPR < 4.25). For underexpanded flows the base pressure increases with increase of NPR and rib aspect ratio. For L/D = 2 also the base pressure increases for NPRs 6 and 7.

• When there is no rib, the enlarged duct wall pressure field exhibit oscillations in the near field in the proximity of the base for NPRs more than 5. For lower NPRs the pressure distribution shows gradual recovery to back pressure till the edge of the duct.

• The wall pressure field of subsonic and sonic flows with rib also shows oscillations for NPRs from 3 to 7. Also, pressure peaks occur for two specific locations of the rib. The pressure peaks for ribs 1 and 2 occur when the rib is at L/D = 2.5. For ribs 3 and 4 pressure peaks are developed when the rib is at L/D = 4.0.

• For Mach 1.6 flow, the pressure peaks for ribs 1 and 2 are found for rib located at L/D = 2.5. For ribs 3 and 4 the peaks occur when the rib is located at L/D = 5.0.

• The results of the effect of rib location on wall pressure and base pressure in a suddenly expanded Mach 1.4, 1.8 and 2.0 supersonic flows show that, introduction of rib increases the base pressure at all pressure ratios. For the given rib location, the base pressure is found to increase with pressure ratio, i.e. with decrease of overexpansion level and increase of underexpansion level. The increase in base pressure is found
to be more pronounced when the pressure ratio is increased beyond NPR of 3.

- The present study explicitly reveals that, the base pressure in a suddenly expanded axi-symmetric duct can be controlled by employing a rib of appropriate aspect ratio as a passive control, without causing wall pressure oscillations of unacceptable level for subsonic, correctly and underexpanded sonic and overexpanded, correctly expanded and underexpanded supersonic flow regimes.

### 5.2 SCOPE FOR FUTURE WORK

- Experiments were conducted for only one area ratio of enlarged duct to that of nozzle exit. Different area ratios can be investigated for a better understanding of the problem.

- Flow regimes of higher supersonic Mach numbers can be investigated to obtain a wide range of information regarding both the base pressure and wall pressure distribution.

- Multiple ribs of varying aspect ratios at different locations of the duct at a time in a well defined manner can be of high technical value.