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Master Cylinder Performance, With and Without Vacuum

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A late model Ford Bronco left the road in a curve and wound up in trees. Its driver insisted that the brakes “shuddered”, which caused lost of control. The truck was inspected in the field by insurance representatives and a mechanic.

They found nothing that would cause the brakes to behave as described, so the master cylinder and vacuum booster were removed for possible further inspection. After the vehicle had been destroyed, the client wanted a bench test of the master cylinder. Nothing was found in the bench test to explain the vehicle behavior described, but this paper will provide some of the performance test results for your benefit.

The pedal linkage was not removed with the parts. The leverage ratio of linkage on several surrogate trucks was a little over 3.1 to 1. A 2 inch diameter air cylinder was arranged to push directly on the booster push rod, and new pressure gauges were secured to the front and back brake ports on the master cylinder. The vacuum port on the booster was connected to a venturi vacuum pump with bypass controls. This style of pump has high capacity with reasonable sensitivity in control.

Normal engine vacuum is 18 to 22 inches of mercury. With a good check valve in the booster line, reservoir vacuum may be held in the upper teens or higher. One of the reference levels for brake application is 13 to 14 in. Hg., which corresponds to a poorly timed engine. For these tests, the vacuum pump was adjusted to provide 13.2 in. Hg.

The results presented here are the output characteristics for application of 0 to 100 psi air pressure (0 to 100 pounds equivalent pedal force.) With no vacuum, the output of the front and rear ports were about the same, an almost linear response about double the input.

The output of the two ports was entirely different with vacuum applied. The response was very much non-linear, as shown in Figure 1. At high pedal effort, the rear port was three times and the front was four times the unassisted response.

Figure 1 is provided for your review just in case you didn't know what to expect. In allegations of failure of applied brakes, the integrity of the vacuum assist features may be as important as the platform brakes.

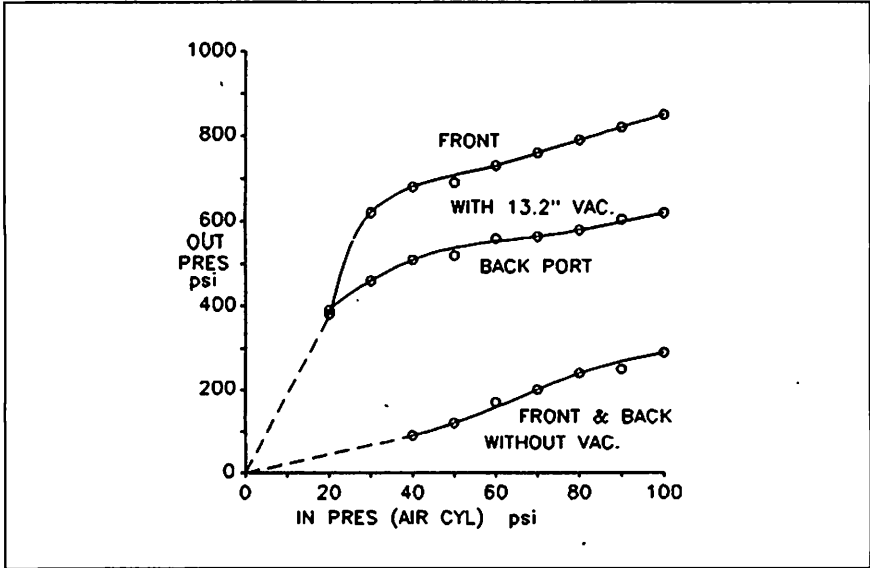


Figure 1

References

Current SAE Standards Handbook, Section 22, J-1153 and J-1154