بنام خداوند جان و خرد

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Maxima Brake System Design

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#NAIAS
NISSAN

- History:

MASAIMA A 15

- Production
- 1981
- Engine
- 4 cylander
- 2.8 lit

MAXIMA V6

- Production
- 1984
- Engine
- 6 cylander
- 2 lit

MAXIMA A315

- Production
- 1988
- Engine
- 6 cylander
- 3 lit

MAXIMA A35

- Production
- 2003
- Engine
- 6 cylander
- 3 lit
- Gearbox
- CVT

MAXIMA

- Production
- 2008
- Engine
- 6 cylander
- 3 lit
- Gearbox
- CVT

reference: Hoshdarnews.ir

- New :

MAXIMA 2018

- Engine:
- VR30DDTTV6
- Gear box:
- Cvt
- Weight:
- 1410 kg
- Top speed:
- 210 km/h

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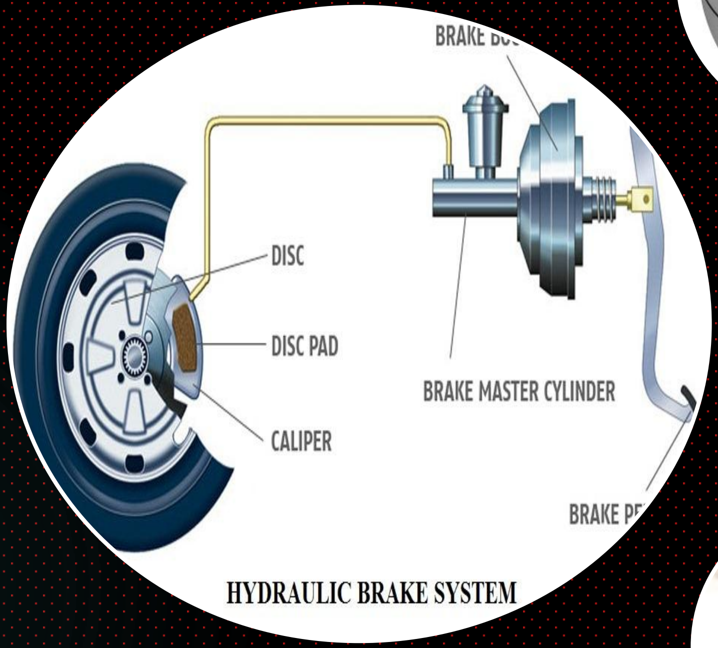
- Characteristics car :

Variable	Value
Length	4897 mm
Width	1860 mm
height	1436 mm
Wheel base	2775 mm
Front track	1585 mm
Rear track	1585 mm
Weight	1581 kg
Weight distribution front-rear	61%-39%

- Characteristics tire :

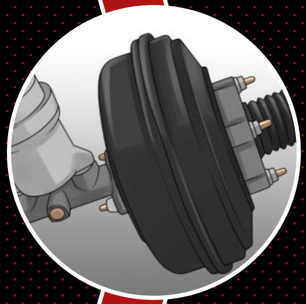
Variable	Value
Rear tires	P245/45VR18
Front tires	P245/45VR18
Braking distance	47.1 m
Front and rear rim	Aluminum
Front and rear brakes	Ventilated disc

- Flowchart :



brakeing design

Brakeing disc



Complex brakeing pump

Brakeing pedal & booster

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1. Braking disc :

- To design the brake disc, the distribution of forces on the front and rear axles must be calculated first.
- By calculating the forces, we now consider the forces needed to brake the front and rear wheels.
- With the braking forces involved, we'll design the brake disc and so on, so that the first part of the calculation ends.

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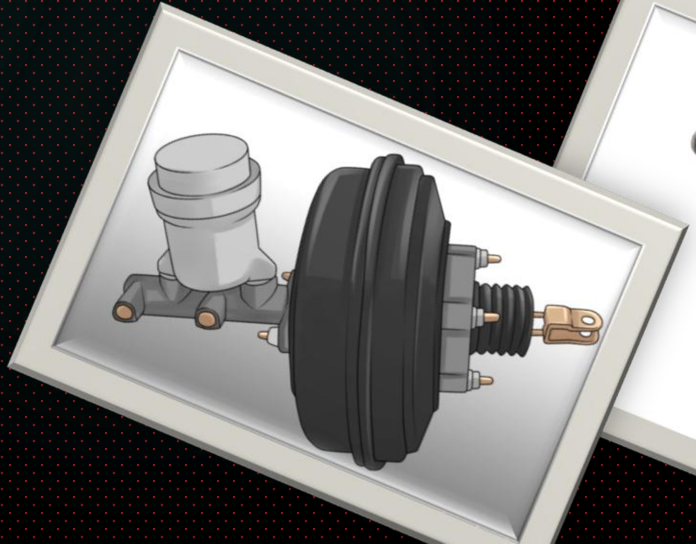
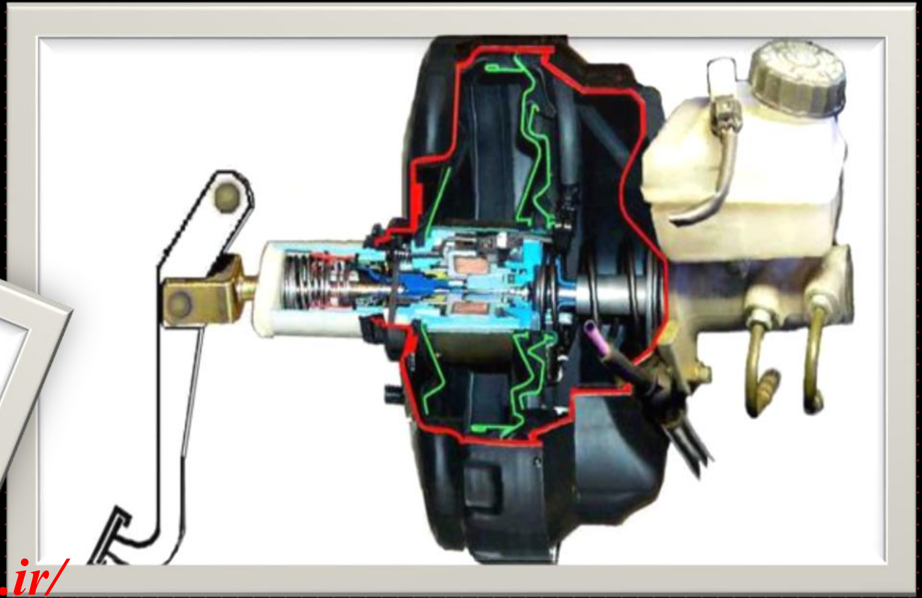
2. Complex braking pump:

- In the further design of the braking system, it turns to the design of the brake pump that produces the oil pressure in the system, as well as the force required to produce the pressure of the oil and the design of the booster to strengthen the leg force and reach the force required to create the desired oil pressure in the system.
- In this section, the size of the booster diaphragm is also determined to reach the desired oil pressure.





3. Braking pedal & booster :

- Now, we will design the brake pedal system that will be stimulated by the driver.
- In designing the pedal system, several components must be considered, including the driver's comfort, as well as the braking force to be created by the driver, which, by changing the pedal dimensions and pedal angle of the pedal relative to the perpendicular and other angles of the pedal, It was sought.

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1.1. Calculations of the forces involved :

$$P_1 = \frac{PL_2}{L_1+L_2} = \frac{PL_2}{E}$$

$$P_2 = \frac{PL_1}{L_1+L_2} = \frac{PL_1}{E}$$

$$N_1 = \left(\frac{L_2}{L_1+L_2} + \frac{zh}{L_1+L_2}\right)P$$

$$N_2 = \left(\frac{L_1}{L_1+L_2} - \frac{zh}{L_1+L_2}\right)P$$

$$p_f = p_1 + \frac{mJh}{E}$$

$$p_r = p_2 - \frac{mJh}{E}$$

$$\omega_i = \frac{0.9 \times V_{max}}{r_{r_i} \times 3.6}$$

$$r_r = \frac{25.4}{2}(D) + 0.923(W)\frac{H}{W}$$

$$\tau_{wi} = T_{wi}\, r_{ri} = \frac{X_i\, PZ\, r_{ri}}{2}$$

$$X_i = \frac{N_i}{P}$$

$$mJ = \frac{P}{g}j = Pz$$

$$X_1 + X_2 = 1$$

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1.2.

Description	Value
Static front axle normal load	9639.8 N
Static rear axle normal load	6164.47 N
Dynamic front axle normal load (at z=0.4)	11000 N
Dynamic rear axle normal load (at z=0.4)	4800 N
Front/rear axles braking force ratio (at z=0.4)	0.69/0.302
Dynamic normal reaction at the road surface for (at zcritical=0.6)	DOW 15980 N GVW 18050 N
Dynamic front axle normal load (at zcritical=0.6)	11700 N
Dynamic rear axle normal load (at zcritical=0.6)	4070 N
Front/rear axles braking force ratio (at zcritical=0.6)	0.74/0.257
Longitudinal load transfer for front (at zcritical=0.6)	11377 N
Longitudinal load transfer for rear (at zcritical=0.6)	79026 N
Average amount of brake's disk for front wheels	330.36 mm
Average amount of brake's disk for rear wheels	330.36 mm
Maximum torque for front wheels	960 Nm
Maximum torque for rear wheels	333 Nm
Front axle instantaneous angular velocity	166.66
Rear axle instantaneous angular velocity	166.66

2.1. Complex braking pump :

$$\dot{Q}_i = T_{wi}\,\omega$$

$$P_a = (p - p_t)A_a\eta$$

$$N_{c1} = N_{c2} = N_c$$

$$A_s = \pi(r_o^2 - r_i^2)$$

$$Q_i = \frac{1}{2}\left(\frac{mV^2Xi}{2}\right)$$

$$\tau_w = 2\mu P_a r_e$$

$$N_c = P_a$$

$$T_w = BF\, P_a r_e / r_r$$

$$\tau_w = 2\mu N_c r_e$$

$$\tau_w = \mu(N_{c1} + N_{c2})r_e$$

$$r_e = r_m = (r_o + r_i)/2$$

$$\tau_{axle} = 4\mu\,(p - p_t)A_a\eta\, r_e$$

$$BF = \eta C^* = 2\mu$$

$$\tau_w = 2\mu\,(p - p_t)A_a\eta\, r_e = BF\,(p - p_t)A_a\eta\, r_e$$

$$T = 2\,\eta C^*\, P_a r_e / r_r$$

$$\text{Scaled value} = \frac{\text{Numerical value of the material property} * 100}{\text{Maximum value}}$$

$$\text{Scaled value} = \frac{\text{Minimum value} * 100}{\text{Numerical value of the material property}}$$

$$\gamma = \sum_{i=1}^{N} \beta_i\, \alpha_i$$

$$T_i = 2\, BF\, P_a r_e / r_r$$

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2.2.

Description	Value
Rate of energy dissipation for front axle	159363.8
Rate of energy dissipation for rear axle	54978.3
Total energy dissipation for front	4289
Total energy dissipation for rear	14490
Inner/outer radius ratio of brake disc	1.42<150
Effective radius of rubbing path	115 mm
Outer radius of rubbing path	135 mm
Inner radius of rubbing path	95 mm
Friction surface area of the disc	0.028 m2
Brake factor	0.8
Inner and outer pad clamp forces	1870 N
Threshold pressure	0.08 M Pa
Inner and outer pad clamp forces	1700 N
Wheel brake torque	3128 Nm

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3.1. Braking pedal & booster:

$$F_{in} = (aF_p - K_p\theta - I_p\ddot{\theta})/b \cong (aF_p)/b$$

$$A_{pad} = \int \phi r dr = \phi(r_o^2 - r_i^2)/2$$

$$\Delta v_{ml} = K_{mc}\ p_L$$

$$F'_d = \eta(A_d - A)(P_{amb} - P_{inlet\ duct})$$

$$P_{disc} = F_d/(\pi(D_o^2 - D_i^2)/4)$$

$$F'_{in} = (\pi D_i^2)/4) \times P_{disc}$$

$$F_{in} = F'_{in} + F_{s1} + F_{s2}$$

$$B = \frac{F_{out}}{F_{in}} \cong \frac{F_d + F_{in}}{F_{in}} = \frac{F_d + A_i \frac{F_d}{A_o - A_i}}{A_i \frac{F_d}{A_o - A_i}} = \frac{A_o}{A_i}$$

$$P = (R_p F_d F_p Q_{mc})/A_{mc}$$

$$stroke = \frac{X_{p_{max}}}{R_p}$$

$$Q = 1/4\ m\ v^2 X_i$$

$$P_{mc} = R_p F_d F_p$$

$$v_{ml} = K_H\ L_r\ p_L$$

$$\dot{q} = (A_{piston}\ p_{piston}\ V)/A_{pad}$$

$$\Delta v_{ml} = K_{mc}\ p_L$$

$$P = (P_{mc} Q_{mc})/A_{mc}$$

$$\Delta v = p_L\ L\ r^3 \left(\frac{\pi}{2} + 2\pi\left(1 - \frac{3v}{2}\right)\right)/E_t$$

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3.2.

Description	Value
Brake lever ratio	4.1
Boost factor	5
Master cylinder surface area	5×10-4 mm2
Minimum input force (master cylinder)	3100 N
Maximum input force (master cylinder)	11210 N
Master cylinder maximum pressure	17.28 MPa
Brake pad angle	60°
Brake pad surface (one pad)	10000 mm2

Conclusions :

- At the moment, all vehicles move to strong engines and generate great power. In order to increase the performance of the car than other cars, the brake system becomes more important than ever before it can stop the car.
- The project aims at re-designing the Maxima 2018 car brakes, and a new way to improve vehicle performance and optimize the braking system of this vehicle up to the parameters

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thank you

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