B. Theoretical Lifting Force

- The theoretical lifting force is determined by vacuum pressure and contact area of the vacuum pad.
- Since the theoretical lifting force is the value measured at the static state, the safety factor responding to the actual operating conditions must be estimated in the actual operation.
- It is not necessarily true that higher vacuum pressure is better. Extremely high vacuum pressure may cause problems.

  - If the vacuum pressure is higher than necessary, an increase in the friction of the pad, generation of cracks, sticking of the pad and workpiece, and sticking of the pad (bellows pad) will occur easily, possibly shortening the life of the pad.
  - Doubling the vacuum pressure makes the theoretical lifting force double, while to doubling the pad diameter makes the theoretical lifting force quadruple.
  - When the vacuum pressure (set pressure) is high, it makes not only response time longer, but also the necessary energy to generate a vacuum larger.

Example) Theoretical lifting force = Pressure x Area **2 times**

Pad diameter	Area [cm²]	**Vacuum pressure [–40 kPa]**	Vacuum pressure [–80 kPa]
ø6	0.28	**Theoretical lifting force 1.1 N**	Theoretical lifting force 2.2 N
ø16	2.01	**Theoretical lifting force 8.0 N**	Theoretical lifting force 16.1 N

4 times

Lifting Force and Vacuum Pad Diameter

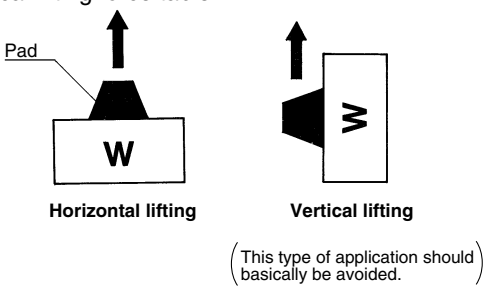
- Set the vacuum pressure below the pressure that has been stabilized after adsorption.
  However, when a workpiece is permeable or has a rough surface, note that the vacuum pressure drops since the workpiece takes air in. In this case, it is necessary to perform a suction test to check the vacuum pressure reached during suction.
- The vacuum pressure when using an ejector is approximately –40 to –60 kPa as a guide.

The theoretical lifting force of a pad can be found by calculation or from the theoretical lifting force table.

Calculation

$$W = P \times S \times 0.1 \times \frac{1}{t}$$

W : Lifting force [N]
P : Vacuum pressure [kPa]
S : Pad area [cm²]
t : Safety factor Horizontal lifting: 4 or more
Vertical lifting: 8 or more



Theoretical Lifting Force

The theoretical lifting force (not including the safety factor) is found from the pad diameter and vacuum pressure.
The required lifting force is then found by dividing the theoretical lifting force by the safety factor **t**.

Lifting force = **Theoretical lifting force** ÷ **t**

Theoretical Lifting Force (Theoretical lifting force = P x S x 0.1) [N]

Pad diameter [mm]		ø32	ø40	ø50	ø63	ø80	ø100	ø125
S: Pad area [cm²]		8.04	12.56	19.63	31.16	50.24	78.50	122.66
Vacuum pressure [kPa]	**–85**	68.3	107	167	265	427	667	1043
	–80	64.3	100	157	249	402	628	981
	–75	60.3	94.2	147	234	377	589	920
	–70	56.3	87.9	137	218	352	550	859
	–65	52.2	81.6	128	203	327	510	797
	–60	48.2	75.4	118	187	301	471	736
	–55	44.2	69.1	108	171	276	432	675
	–50	40.2	62.8	98.1	156	251	393	613
	–45	36.2	56.5	88.3	140	226	353	552
	–40	32.2	50.2	78.5	125	201	314	491