

Lab #2

LAB task – check students' skills in dimensional chains modeling and calculating using the method of complete interchangeability (maximum-minimum).

Guidelines

In a product manufactured at an enterprise, parts occupy a certain position relative to each other in accordance with their functional purpose. Therefore, the dimensions of the parts in the product are interconnected. Dimensional relations of a part or product are analyzed using the theory of dimensional chains.

A dimensional (construction) chain is such dimensional chain that determines the distance or relative rotation between the surfaces or axes of the part surfaces in the product, i.e. dimensional chain, for solving tasks of ensuring accuracy in the design of products.

- Any chain consists of the parts: chain elements
- Chain elements can be:
 - **Increasing** (\rightarrow_A), if such element of the dimensional chain increase with the closing element,
 - **Reducing** (\leftarrow_A), if such element increases while the closing element reduce
 - **Closing** (A_0) – an element in a dimensional chain that is the initial one when setting a task or the last one as a result of its solution.

The problems posed can be realized by solving **direct** and **inverse** tasks:

- **Direct task** - According to the given nominal size and tolerance (deviations) of the original element (of dimensional chain), the nominal dimensions, tolerances and maximum deviations of all component elements are determined.
- **Inverse task** - According to the established nominal dimensions. the tolerances and maximum deviations of the constituent links of the dimensional chain determine the nominal size, tolerance and deviations of the closing link.

Example:

According to the given dimensions and tolerance fields of the component links of the part (Figure 1), calculate the closing link.

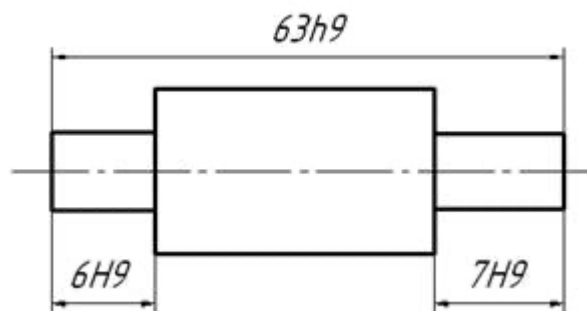


figure 1

Solution:

1. We draw up a diagram of the dimensional chain (Figure 2) from it we establish that links A2 and A3 are decreasing, and link A1 is increasing.

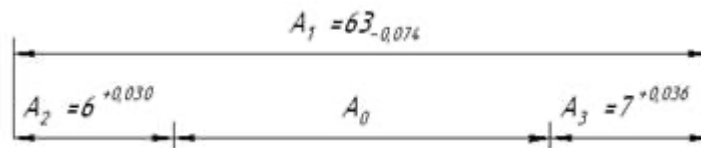


figure 2

2. The calculation is made by the maximum-minimum method.

Limit deviations of links, microns:

$$ES(A_1) = 0; EI(A_1) = -74;$$

$$ES(A_2) = 30; EI(A_2) = 0;$$

$$ES(A_3) = 36; EI(A_3) = 0;$$

The tolerances of the links:

$$TA_1 = 74 \mu\text{m};$$

$$TA_2 = 30 \mu\text{m};$$

$$TA_3 = 36 \mu\text{m}$$

The nominal value of the closing link is calculated by the formula:

$$A_0 = \sum^n A \uparrow - \sum^p A \downarrow$$

$$A_0 = 63 - (6 + 7) = 50 \text{ mm}$$

Where,

n is the number of increasing elements,

p is the number of reducing elements.

The limiting dimensions of the closing link are written out according to the formulas:

$$A_{0 \max} = \sum^n A_{\max} \uparrow - \sum^p A_{\min} \downarrow$$

$$A_{0 \max} = 63 - (6 + 7.36) = 49.64 \text{ mm}$$

$$A_{0 \min} = \sum^n A_{\min} \uparrow - \sum^p A_{\max} \downarrow$$

$$A_{0 \min} = 62.926 - (6.030 + 7) = 49.896 \text{ mm}$$

Deviations of the closing link are calculated by the formulas:

$$ES(A_0) = \sum^n ES(A \uparrow) - \sum^p EI(A \downarrow)$$

$$ES(A_0) = 0 - (0 + 0) = 0 \text{ mm}$$

$$EI(A_0) = \sum^n EI(A \uparrow) - \sum^p ES(A \downarrow)$$

$$EI(A_0) = -74 - (30 + 36) = -140 \text{ mm}$$

The tolerance of the closing link is determined by the formula:

$$TA_0 = ES(A_0) - EI(A_0); TA_0 = 0 - (-140) = 140 \mu\text{m}$$

LAB sequence order

1. Select your option by your number in the journal list.
2. Draw a sketch of the part (Figure 3).
3. Determine the dimensional chain for calculation.
4. Calculate the dimensional chain by the method of complete interchangeability (maximum-minimum method).
5. Answer the questions.

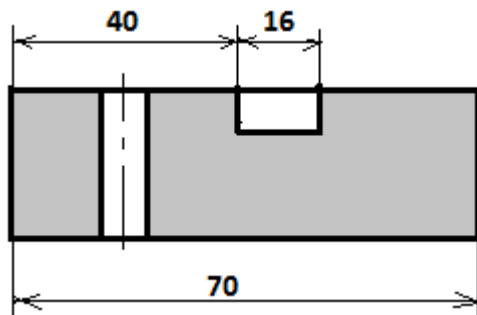


figure 3

Option	A ₁ , mm	A ₂ , mm	A ₃ , mm	TD ₁ , μm	TD ₂ , μm	TD ₃ , μm
1.	80	32	25	+30 0	+25 -25	+21 0
2.	100	34	32	+35 0	+25 0	+21 -21
3.	63	30	20	+30 -30	+21 -21	+21 -21
4.	125	36	50	+40 0	+25 -25	+25 -25
5.	100	32	45	+54 0	+39 0	+39 0
6.	125	34	32	+40 -40	+25 -25	+25 -25
7.	63	36	16	+30 0	+25 -25	+18 -18
8.	80	38	20	+35 -35	+25 -25	+21 -21
9.	125	32	45	+40 0	+25 -25	+21 -21
10.	100	50	25	+54 0	+39 0	+33 -33

Test questions:

1. What is called a dimensional chain?
2. What is called the closing link of the dimensional chain?
3. Which chain links are called increasing, which are decreasing?