(b)Using the adjacency matrix computed above calculates the product of the reachable matrix R.

$$R = \begin{pmatrix} & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 \\ 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 2 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 3 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 4 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 1 \\ 5 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 6 & 1 & 0 & 0 & 1 & 0 & 1 & 1 & 1 \\ 7 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 8 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

(c) By decomposing reachable matrix, the reduced matrix of the reachable matrix is obtained.

Considering the above reachable matrix, we can see that the reduced matrix is the reachable matrix because the matrix has no strongly connected components.

(d)By dividing the level, a hierarchical model of the product is established.

Compute $E_0 = (1,1,1,1,1,1,1,1)^T$, then $\mathrm{R_e}\, E_0 = (2,2,1,3,2,5,1,1)$. The third, seventh and eighth vectors are all valued as one, the corresponding screw Max16 screw Max12 and the matrix are the lowest-rise ($L_1 = \{3,7,8\}$).

Value the divided level location as zero, while other bits are reserved for one, then $E_1 = (1,1,0,1,1,1,0,0)^T$ $\mathrm{R_e}\, E_1 = (1,1,0,1,1,3,0,0)$. The first, second, fourth and fifth vectors are all valued as one, the corresponding jaw, cover I, pad block, and cover II are the second-rise ($L_2 = \{1,2,4,5\}$), the screw is the third-rise. Figure 2 shows the hierarchical model of the clamping jaws.

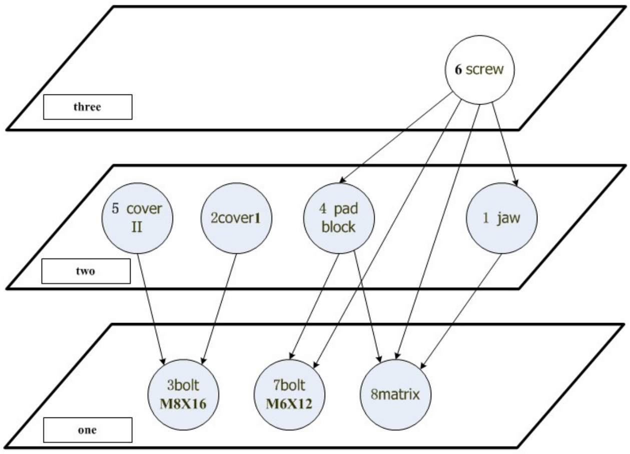

Figure 2. hierarchical model of clamping jaws diagram

The hierarchical model can clearly reflect the relationship of the connection and influence between the various components of the product. The level model diagram analysis shows that the higher the level, the greater influence the parts in the level on the entire product structure. Therefore, modifying the structure and size of such parts should be avoided during improving product design and redesign. For example, the screw in the figure, we should try to avoid changing it. Pad block, it is not the highest level, but because it affects two parts and is impacted by one part, we should also do our best avoid changes in this part. For the cover I and cover II, as they have no in-degrees and it affects the standard bolts, changing the structure and size of the cover to the diversification of products can be considered.

VI. CONCLUSION

By applying interpretive structural modeling to the product structure analysis, this article proposes one structure analysis method that based on interpretative structural model. Product structure hierarchical model constructed using this method can clearly reflect the composition and the relationship among the various parts, and the hierarchical model can distinctly mirror the structure composition of the product, influence and relation among each components, providing the basis for the design. Finally, taking the clamping jaws as an example, the methods described above are verified.

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