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Design Of Engineering Complex Equipment For Installation Of Modules From Element Facade System

Irena Petrova

Department MEMETE, Sliven Engineering - Pedagogical Faculty
Technical University of Sofia
Bulgaria, European Union

Abstract

In this paper is proposed construction of auxiliary equipment for direct mounting of modules of elements facade system, consisting of two separate independent working complexes – cantilevered trolley hoist trace and rotating lever - vacuum extractor module. Its elements are built and simulated in environment of automated design system TopSolid'Design [6]. The proposed structure is universal and provides, by adjusting the positions of individual components for installation of identical elements family details. The design fully meets the requirements for high accuracy, reliability, stability installation characteristic of complexes of this type.

Keywords: Elements facade system, Single Flute End Mill Cutters, High-speed milling.

1. Introduction

Demand for high-tech innovative architectural solutions on elemental facades requires accurate modeling of engineering systems for their installation. They allow direct guidance based on the surfaces of the individual modules, such as to avoid the need to build assembly cradling. Modules element facades are constructed as a set of aluminum profiles, glass and aluminum composite panels - Figure 1. The technology for forming the connecting surfaces of the aluminum profiles building frame structure within composite and decorative panels, include high-speed mlling with single flute end mill cutters [1,7]. The equipment allows manipulation with modules whose maximum dimensions reach 2700mm x 3480mm.

Ensuring correct attachment surfaces with the required size and quality is mainly dependent on the correct choice of cutting conditions when operating single flute end mill cutters under intensive conditions metal removal, and thus their reliability [3,4,5,9].

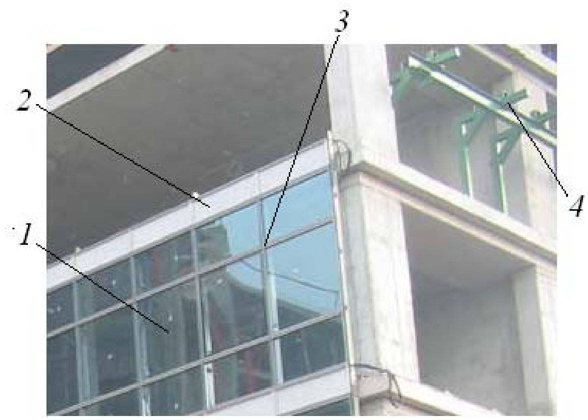

Figure 1 Elements Facade System:
1.Modul, 2. Composite Panel, 3. Aluminium profile, 4. System Installation

2. Design of cantilever trolley hoist trace

Cantilever trolley hoist trace is implemented as a set of elements of the console to mount a T-shaped supporting profile, with a length of 4000 mm that move hoist. Possibilities for height adjustment, rotation module and translation axis perpendicular to the direction of the hoist. System is with manual positioning. The entire structure is mounted on filling plates previously earned in the construction, or beams of the building structure or installation site. The desired position is fixed with six M12 threaded connections.

The maximum design load with which the cantilever trolley hoist trace could be loaded with reporting safety factor is Q = 10000N, lifting height - H=30m, lifting speed - $V_{max.}$=10m/min. For the needs of construction used chain hoist series CLN.

In general terms the scheme of the facility is shown in Figure 2. It consists of the following major elements, tested reliability [8]:

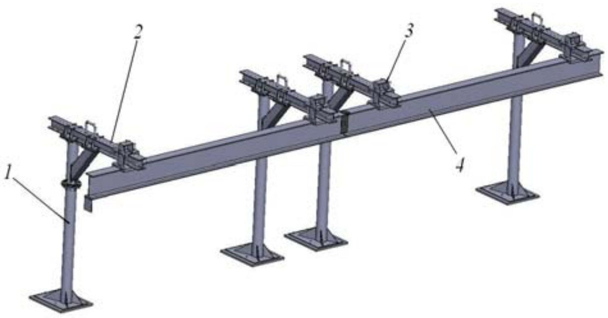

Figure 2 Cantilever trolley hoist trace:
1. Bracket, 2. Girder , 3. Suspension module, 4. Track girder

Each Cantilever trolley hoist trace consists of Bracket 1, Girder 2, Suspension module 3, Track girder 4. A trolley hoist trace is built as a set of modules - two Brackets and Girder 4m. Each Bracket is a component and allows easy installation. Can be rotated 360 degrees. The skeletal structure of the module is welded profiles Ø139h5 and K120x120x4 - hot rolled steel 08KP.

Due to the complexity of the facility will continue its consideration of examining pooled units into its composition and subsequently the individual components.

The brackets are mounted on filling elements and fixed with screws. Each bracket has two elements connected with screws and allows rotation of 360° - based console and console stand. The Girder is movable and is fixed by the jaws. The suspension module moves along the beam and in the vertical direction is adjusted by a threaded connector.

Track girder also hung to module jaws. The structure is self-supporting and allows easy and quick installation. Elements for keeping and capture are made from standard profiles and are interchangeable. When transporting they are dismantled and moved. The Suspension module is limited by two stop at the front and rear of the bar.

3. Design of the rotating lever - vacuum extractor module

The rotary module is implemented with two mutually perpendicular shoulder structures which are screw and/or vacuum grippers. Each arm of the handle provides two degrees of freedom in direction both translational movements. The device provides manipulating elements with a total weight of Q = 10000N. Device is manually operated. Axis is established in rolling bearings. The desired position of the element is fixed with a thumb, a discrete interval of 45°. The arms are performed by standard profiles.

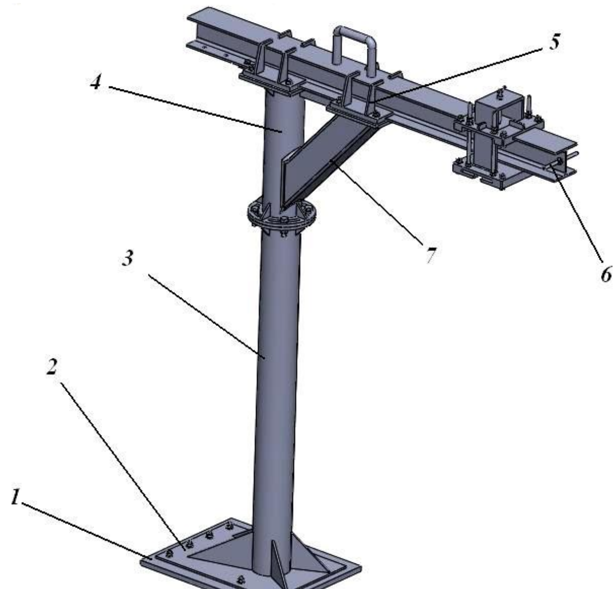

Figure 3 Bracket:
1. Board, 2. Base flange, 3. Plinth, 4. Bed plate, 5. Jaws, 6. Detent, 7.Rib

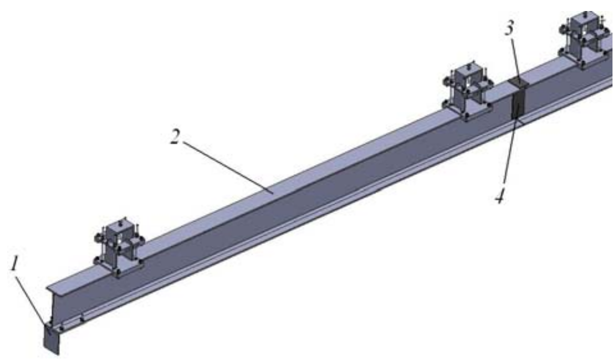

Figure 4 Track girder:
1. Final Detent, 2. IPE 270, 3. Vertical splice bar, 4.Horizontal splice bar.

Materials for the construction of individual elements are selected according to their functional purpose:

- Body of the rotation mechanism, disk and fins - ASt3 - sheet, good weldability,
- Axle - 40X - high strength and hardness after heat treatment,
- Lids, liners and spacers - 45 economical method for preparing a preform and easy workability of the surfaces,
- Profiles are 08KP.

In general terms the scheme of the facility is shown in Figure 5. It consists of the following major elements:

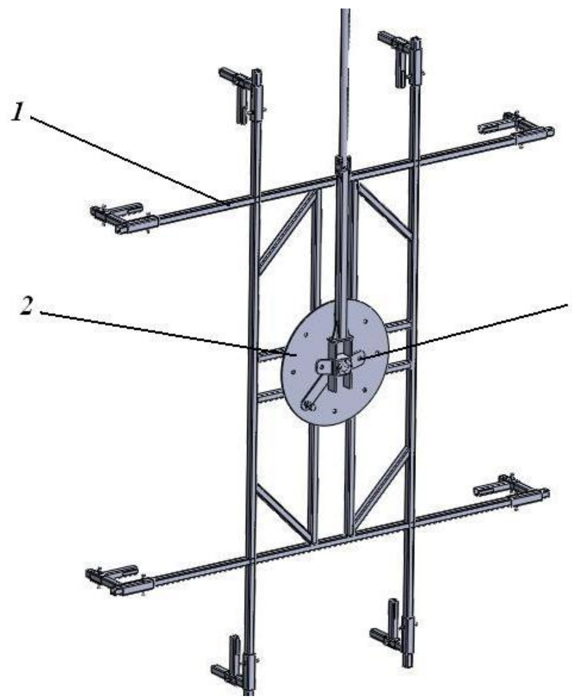

Figure 5 Rotary module:
1. Frame, 2. Disk, 3. Rotating mechanism

Each mechanism is provided with two horizontal and two vertical gripper. They end with knife or vacuum (paws) executive bodies. Frame 1 with catchers welded to disk 2, which in turn through axle is supported by the rotary mechanism 3. The entire device system by solid belt tensioners are fitted to the hoist hook. The facility allows each element to be rotated through 45°. Skeletal structure is built by welded profiles K40x40x3. Due to the complexity of the facility will continue its consideration of examining pooled units into its composition and subsequently the individual components.

Device by hanging are established on the working body of the hoist then manually brings to the elements to be manipulated. Depending on the type, they shall be borne by device by mechanical screw or vacuum grippers.

Angular components of catchers are released, the device is based on the module of element facade, and then the angular components are mounted again and tighten the locking screws.

The mechanism router by turning the handle. It is pre-assembled and allows the mechanism as a whole in the transport have a smaller size. After the stretch the handle by turning the nut located on the upper half is harvested slack in the lever system. Elements for keeping and capture are made from standard profiles and are interchangeable. The axis of which is secured around the module is supported by the body and is made of steel 40X.

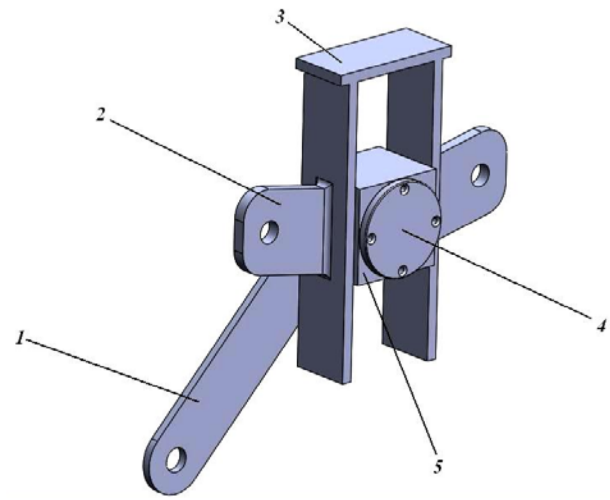

Figure 6 Rotary mechanisms:
1. Jig bar, 2. Hoisting eye, 3. Suspension member, 4. Bearing cap, 5. Body

4. Strength deformation check - FEM analysis

After having completed the design and development defined operating forces must do strength tests of the busiest parts. They are performed by finite element method, whose sequence is indicated in the source [2]. Here, because of the complexity and importance of the observance of the geometrical precision work with higher safety factors. Strength check is especially important for equipment designed for lifting heavy and deformable elements such as modulate of elememntite facades constructed in the model is analyzed after conversion into SolidWorks CAD system through - CosmosXpress. Figure 7, a, b are represented strength and deformation check in the busiest part of the structure namely jaws.

The results of the analysis show that on strength calculations - stress σ [MPa] eligible for construction are 351MPa and implemented in endangered sections 58 MPa, the structure is a safety factor k_s = 6,051. In deformation check deflection limit is δ=6e-0.01, realized is δ = 4,35e-0.002, a safety factor k_δ=13,81. Construction fulfill its function, even under extreme loads caused by the dynamic behavior of the load.

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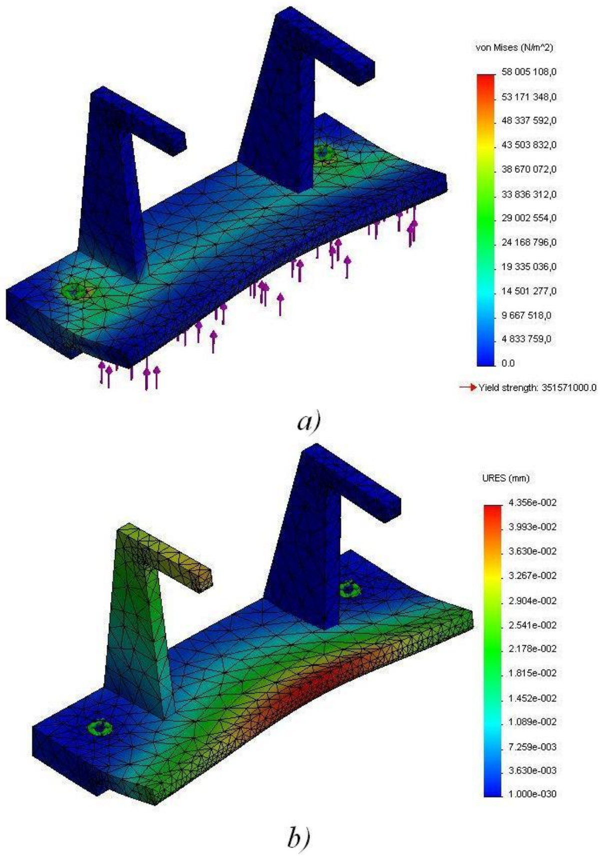

Figure 7 Jaw - FEM analysis:
a) verification of strength, b) deformation check

3. Conclusions

1. Proposed is a universal structure for direct mounting of modules of elements facade system consisting of two complex - cantilevered trolley hoist trace and rotating lever - vacuum extractor module.

2. Different groups of prefabricated elements, which ensure their mobility and tunable. Allow working dimensions of the modules to 2700mm x 3480mm and weight Q=10000N.

3. The analysis by finite element method proves the feasibility of the structure even at loads exceeding permissible

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Irena Petrova, is Assistant of Mechanics, Machine Elements and Engineering Graphics at the Rousse University "Angel Kanchev", Bulgaria. She is and a PhD student in Department MEMETE, Engineering Pedagogical Faculty – Sliven,Technical University of Sofia. She got his M.Sc. in Manufacturing technology and management from the RU "Angel Kanchev", Bulgaria (1994). Her interests include the design of tooling system and metal structures.