KAUNAS UNIVERSITY OF TECHNOLOGY

MECHANICAL ENGINEERING AND DESIGN FACULTY

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FUNCTIONAL PARAMETER ANALYSIS OF BRACKETS FOR EXTERNAL WALL CLADDING

Master's Degree Final Project

Supervisor
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KAUNAS, 2016

KAUNAS UNIVERSITY OF TECHNOLOGY

MECHANICAL ENGINEERING AND DESIGN FACULTY
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FUNCTIONAL PARAMETER ANALYSIS OF BRACKETS FOR EXTERNAL WALL CLADDING

Final project for Master's degree

MECHANICAL ENGINEERING AND DESIGN 621H30001

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Functional Parameter Analysis of Brackets for External wall Cladding

Final Project

DECLARATION OF ACADEMIC HONESTY

____ May 2016

Kaunas

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MASTER STUDIES FINAL PROJECT TASK ASSIGNMENT
Study programme MECHANICAL ENGINERING - 621H30001

Approved by the Dean's Order No. V25-11-7 of May 3rd, 2016 y

Assigned to the student **Movlee Manoharan**

(Name, Surname)

1. Title of the Project

Functional Parameter analysis of brackets for external wall cladding

2. Aim of the project

The aim of the project is to increase the strength of the bracket and analyse by using different materials.

3. Tasks of the project

• Conducting experimental analysis on bracket. • Obtaining stress and strain curve. • To implement a new design of bracket. • To avoid deformation by changing different material. • To avoid corrosion in the bracket.

4. Specific Requirements

No specific requirements

5. This task assignment is an integral part of the final project

6. Project submission deadline: 2016 May 20th

Task Assignment received Movlee Manoharan ________________

(Name, Surname of the Student) (Signature, date)

Supervisor Dr. Assoc. Prof. Rasa Kandrotaitė Janutienė ________________

(Position, Name, Surname) (Signature, date)

Movlee Manoharan. Functional parameter analysis of bracket for External wall cladding. Masters in Mechanical Engineering Supervisor Assoc. Prof. Dr. Rasa Kandrotaitė Janutienė; Kaunas University of Technology, Mechanical Engineering faculty, Mechanical Engineering department.

KEYWORDS: Bracket, external wall cladding, stress, strain, deformation.

Kaunas, 2016.

SUMMARY

In the European union the "European Technical Approval Guidelines 034" is used for External wall cladding process. It's a type of protective layer where it can control weather and noise pollution. The guidelines enumerates for the purpose of external wall cladding installation, a bracket design , where the brackets are attached with panels. In cladding the bracket is made of steel and the connecting rod is aluminium where the corrosion The displacement of the bracket changes due to constant load. Studies have shown that by changing the design and material properties the strength of the bracket is increased.

In this research work we had the specimens made of structural steel (S 235). A new design is implemented for the bracket using solid modelling computer aided design and computer aided engineering Solid Works. Designed bracket is analysed in commercial solver Ansys (non – linear analysis and bi-linear method was used). The decision on this analysis was arrived after conducting a tensile test on the specimens (structural steel S 235), from this test it was understood that this is a non linear material. Three different materials (alloyed steel, unalloyed steel and a structural steel) where analysed using the same methodology.

By improving design the strength of the bracket is improved and also by using different materials the capacity of the bracket is increased. To improve the bonding of zinc coating with steel a resin can be used so, the corrosion is reduced.

Movlee Manoharan. Laikiklių pastatų šiltinimo konstrukcijoms funkcinių parametrų analizė Masters in Mechanical Engineering Supervisor Assoc. Prof. Dr. Rasa Kandrotaitė Janutienė ; Kaunas University of Technology, Mechanical Engineering faculty, Mechanical Engineering department.

ŽODŽIAI: laikiklis, pastatų šiltinimo konstrukcijos, įtempiai; poslinkis, deformacija.

Kaunas, 2016.

SUMMARY

Europoje temperatūra dažnai yra neigiama, todėl namo be papildomo išorinio sienų apšiltinimo šildymas dažnai būna neefektyvus arba nepakankamas. Norint išvengti vidaus patalpų temperatūros svyravimo, išorinės pastatų sienos gali būti šiltinamos papildomai. Papildomos sienų šiltinimo konstrukcijos taip pat padeda išvengti drėgmės ir triukšmo, sąskaitos už šildymą sumažėja. Šiltinimo konstrukcijose naudojami laikikliai yra tie elementai, kurie laiko ne tik apkrovas dėl šiltinimo konstrukcijos svorio, bet taip pat ir susidarančias dėl nepalankių oro sąlygų.

Eksploatuojant laikiklius, dėl temperatūros pokyčių, konstrukcijos svorio, nepalankių oro sąlygų, laikikliai gali deformuotis. Norint padidinti laikiklių mechanines charakteristikas, buvo pasiūlytas naujas laikiklio dizainas ir medžiaga.

Medžiagos mechaninių charakteristikų nustatymui ir įtempių-deformacijų kreivės užrašymui buvo atliktas tempimo bandymas.

Laikiklio projektavimas buvo atliekamas Solid Works programine įranga, laikiklių deformavimo analizė buvo atlikta ANSYS aplinkoje.

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INTRODUCTION

External wall referred as cladding they are made up of materials like stone, panels, metals and fibre cement. External walls are vertical elements enclosed to the building. Walls must able to exclude rain, snow, wind and sometimes heat and glare from sun. External envelope of building should not provide a medium for fire spread if it's likely to be risk to health and safety. It must be able to adequately resist the penetration of weather from outside to inside of the building.

The utilization of flammable materials for cladding structure, or of burnable warm protection as an over-cladding or in ventilated pits, may present such a danger in the proposed structures, despite the fact that the procurements for outer surfaces may have been fulfilled.

Considering the occasion of flame breakout in the building, the dividers of the building are required to restrain the spread from space to room of the flares, smokes and gasses. The outer dividers ought to satisfy the commitment of containing the flame inside the working for endorsed timeframe, consequently restricting spread to adjoining structures. It is eventually fundamental that the dividers have the capacity to perform their basic capacities amid the flame until all inhabitants have had adequate time to get away. The materials must be precisely picked in order to oppose fore to the most extreme. The instability of the materials must as low as could be expected under the circumstances to counteract fast spreading of the flame.

These dividers are for the most part protected by putting some type of warm component within and rendering the outside. The thickness of these items will rely on upon the thickness and kind of piece utilized.

PROBLEM DESCRIPTION

The project deals with the bracket used in external wall cladding process. The material of the bracket is (structural steel S 235). The displacement changes in the bracket due to wind and constant load of the panels which are attached with the bracket. In cladding the wing of the bracket is connected with aluminium rod where corrosion takes place in the clamp of the bracket.

In this process aluminium and polymer materials can’t be used as bracket in wall cladding. Technically Aluminium has low coefficient of energy it can’t withstand constant loads and Polymer materials are easily burnt.

GOAL

The goal is to reduce the deformation of the bracket, by design improvement and by changing material of bracket. To avoid corrosion at cladding fixing, Coatings can reduces the corrosion of the bracket.

TASKS

- Tensile test to obtain stress and strain curve.
- To implement a new design of the bracket.
- To compare the loads of both design improved and without improvement.
- To compare the loads for three different materials with the design improved bracket.
- To avoid corrosion in the bracket.

1. LITERATURE REVIEW

External wall cladding is protective layer which separates building structure and interior from exterior components as noise, heat, wear and moisture. A cost of cladding structure is high and maintenance is needed. Resisting bracket of cladding holds the load where the one side is connected with substrate and the other side is fixed to the cladding sub frame [1].

1.1 Materials used for external wall cladding

In external wall cladding, element and fixing material is the major part. Materials used in external wall cladding is shown in Table.1.1 and also fixing materials used in wall cladding [1].

Table 1.1 Materials used for wall cladding[1]

Cladding element material (examples)	Fixing material (examples)
Metal, wood based, laminates, fiber cement	Corrosion protected steel, stainless steel composite as nails, screws or bolts
Resin mortar, stone, ceramics	Stainless steel anchors
Fiber reinforced cement, laminates	Aluminum alloy profiles
Plastics	Aluminum alloy in form of screws
Cement particle boards, fiber cement	Corrosion protected steel, stainless steel
Ceramic tiles, fiber reinforced, terra cotta	Stainless steel
Metal cassette	Stainless steel and Aluminum alloy resisting bracket
Terracotta tiles, wood based panel	Corrosion protected copper in form of brackets

1.2 Performance and functions of external wall cladding

- Control heat stream
- Control wind stream
- Control noise
- Control fire
- Control water vapor stream
- Control downpour infiltration
- Control light, sun oriented and other radiation
- Provide rigidity and strength
- Be economical
- Be stylishly satisfying
- Be durable

The divider structure and cladding must accomplish the accompanying execution prerequisites. In planning outline points of interest, we should consider each of these will be accomplished [2].

1.2.1 Load Transfer

Wind loads must be bolstered and exchanged back to the auxiliary casing and accordingly to the building establishments.

1.2.2 Warm Performance

The outer rooftop must keep heat in the inside environment especially in the winter. The cladding framework in this way should exhibit a boundary to warm misfortune. Also, the outer divider must help with averting over the top sun powered warmth pick up in the mid-year and might be required to help with cooling the inner environment relying upon the ventilation methodology that is chosen for the building.

1.2.3 Temperature Movement

The divider must be fit for adapting to development and withdrawal compels that will be set up by recurrent changes in outside temperature.

1.2.4 Relative Movement

The divider must be equipped for adapting to relative development amongst itself and the bars and sections that involve the edge that the divider and rooftop is connected to or suspended from.

1.2.5 Avoidance of outer components

The divider must keep the entrance of dampness, either as a consequence of surface clamminess and keep running off or as an aftereffect of wind driven downpour, and it might need to keep the permission of outside air.

1.2.6 Sound

The outer divider and the rooftop ought to anticipate sound move in both headings amongst inner and outside situations.

1.2.7 Ventilation

Contingent upon how the building's inner surroundings is to be made do with respect to air quality, the divider/rooftop might be required to concede ventilation or on the other hand to avoid air penetration [16].

1.2.8 Openings

The outside cladding must fuse windows with the end goal of conceding sunshine and giving a perspective in all circumstances. In any case, in light of this the divider ought to likewise avert unreasonable sun based glare on surfaces. Combustibility of the materials must as low as would be prudent in order to anticipate fast spreading of the flame.

1.3 Assembly of external wall cladding

In external wall cladding the one end of the bracket is fixed in wall where, the other end cladding process takes place. Sub frame or resisting bracket is fixed in wall with screws and bolts. Now, the aluminium rod is cladding with the resisting bracket with bots and screws, after the cladding process panel is fixed with the aluminium rod. Thus the external wall cladding installation is done shown in figure 1.1 [1].

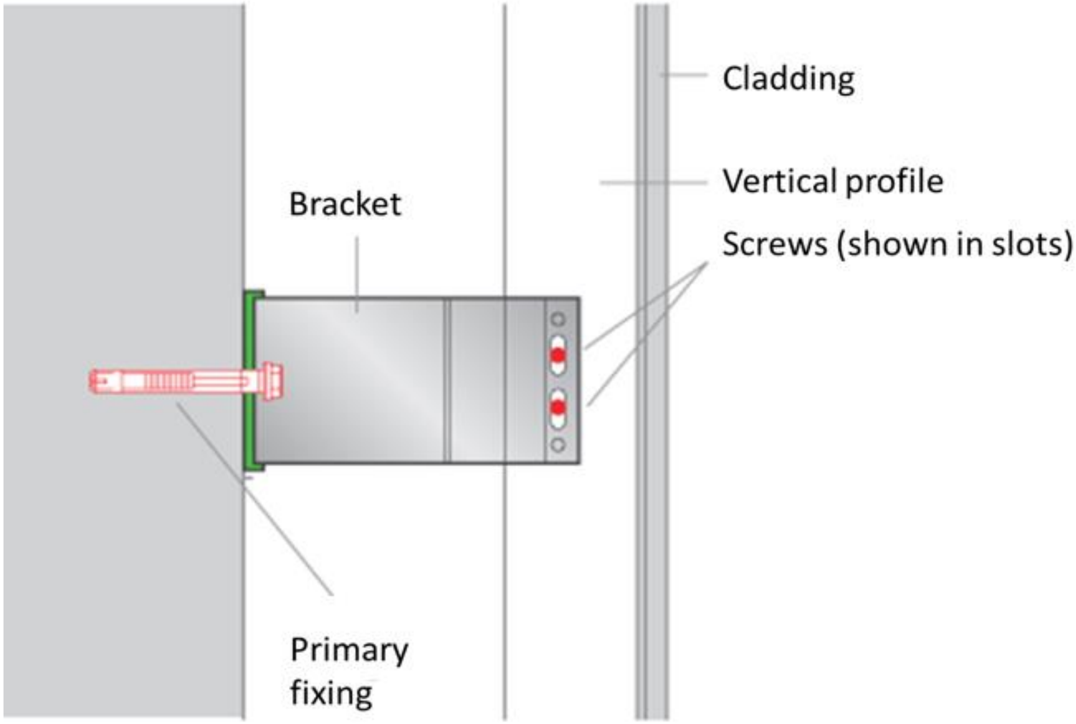


Figure 1.1 Assembly of external wall cladding [1]

1.4 Advantages and disadvantages of external wall cladding process

Advantages

- Controls noise from outside the building
- Weather is controlled by using cladding
- Building wear is controlled
- Moisture is controlled
- Beauty of external
- Saves power in winter by using external wall cladding

Disadvantages

- Initial cost is high
- Time is needed for cladding
- Maintenance is high due to corrosion and wear of the panels
- Building strength reduces slowly due to cladding fixing.

1.5 Facade system

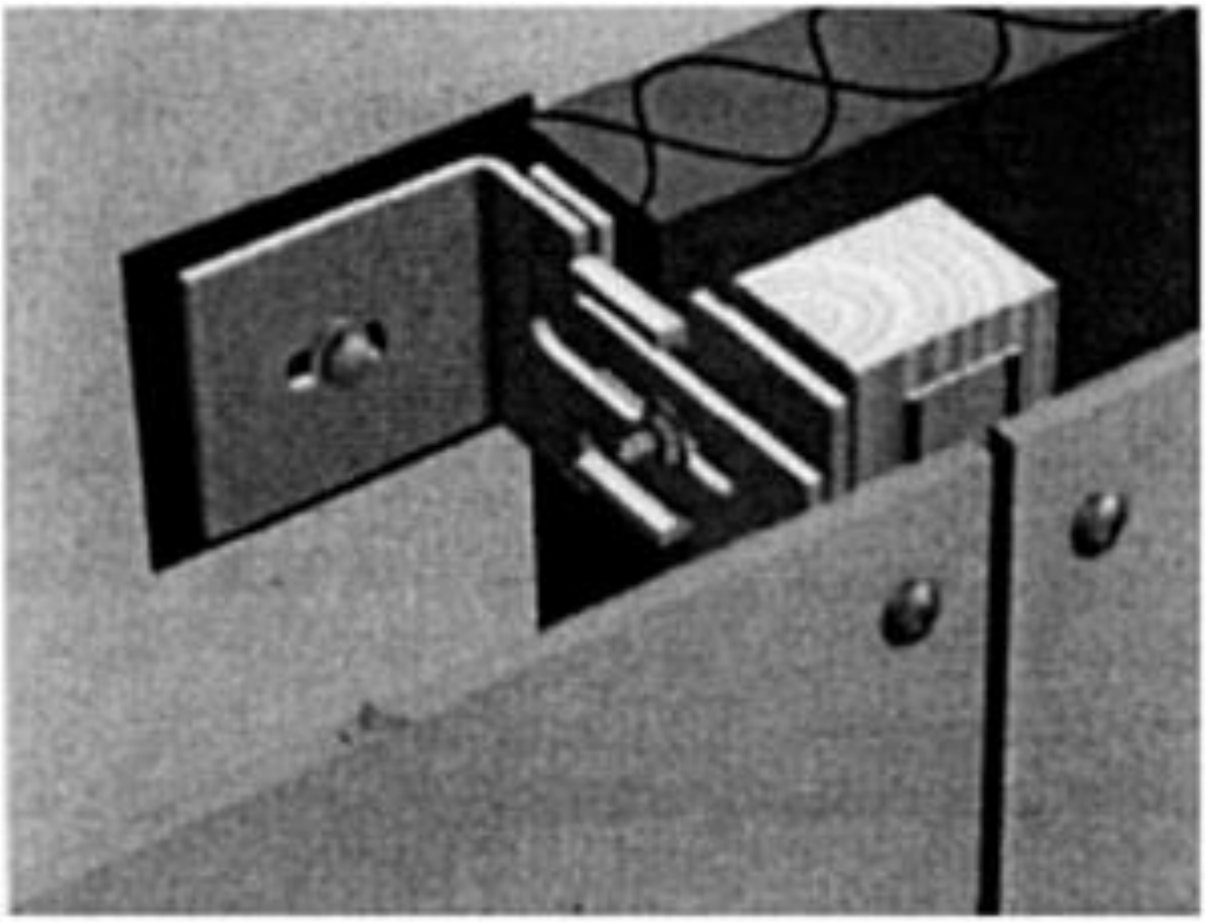


Figure 1.2 small size bracket [3]

A facade system basically consists of an inner support structure in which the thermal insulation at its outside, and subsequently fixed prefabricated panels of small dimensions together with unfilled is placed. It is created, so an air gap between the insulation and the panels, thereby ensuring correct ventilation of this space [3].

In figure 1.2. This ventilation should allow the evacuation of moisture that may arise from possible infiltration through the outer coating, or any condensation occurring within the design element. For these assumptions are warranted, the air gap will have a minimum thickness of 2 cm [10].

1.6 Classification of cladding construction

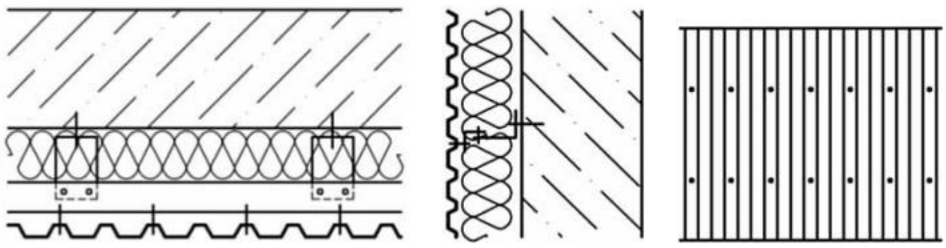
Structures appearances have been changing because of the advances in building innovation and outer divider cladding materials. Each new divider cladding material brings its own development strategy and every procedure might be distinctive contingent upon the material's properties, for example, measurements, unit weight, association sort and detail plan. The term "cladding" is frequently utilized as a general reference to a wide assortment of normally happening and manufactured, or man-made, building envelope materials, parts and frameworks.

In building phrasing, cladding is a non-basic material, a defensive layer or covering that is settled on the external surface of a building or a structure to ensure the building envelope against dampness and outside components, and to give stylish purposes. Frequently in building development, cladding or utilization of one material over another is finished to finish the cladding as a framework. Regularly, these components are quarried, fabricated or generally created what's more, or adjusted to render them appropriate for use on the outside of a building or structure. The key procedures of divider development are cutting and amassing, in addition to form casting the cladding material by utilizing auxiliary materials at whatever point vital. Those applications have diverse natural sways amid development process depending on the cladding framework and its development procedure in specific. Outside divider cladding materials can be amassed on the building surface/shell by utilizing distinctive development methods. Development strategies contrast as indicated by measurement, structure and unit weight of the cladding material, sort and measurements of the sub-development and establishment materials, building tallness, layers of the cladding framework for example, warm protection, waterproofing, fixing, and so on.

Cladding materials consist of sub frame, fixing rods, nails, screws and rivets [13].

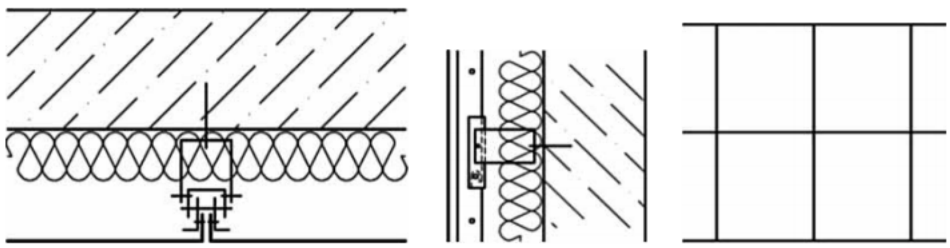
1.7 Types of construction techniques

Construction of external wall cladding has different techniques which are shown below. In figure 1 Installing cladding by sub-construction screw method where they mostly used in Europe. In figure 1.3 and figure 1.4 Constructing with special anchorages used commonly used. In figure 1.5 Installing sub-construction by welding where, instead of screws and bolts welding is given. In figure 1.6 adhesive technique is preferred for small size cladding because adhesiveness can’t withstand more loads compared to other techniques. In figure 1.7 and figure 1.8 wall core installation method is followed where both are with anchorages and adhesives [13].



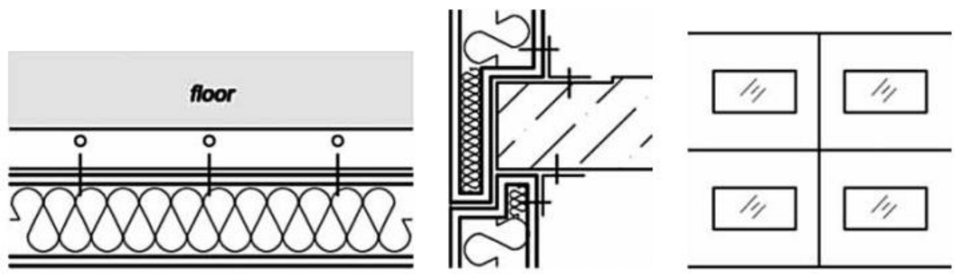
Plan Section Elevation

Figure 1.3 Installing sub-construction screw [13]



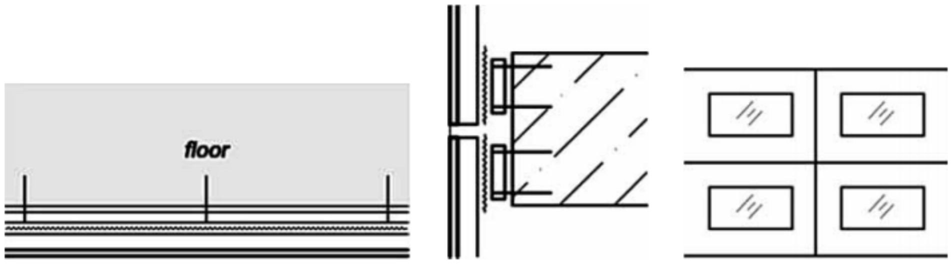
Plan Section Elevation

Figure 1.4 Installing sub-construction special anchorages [13]



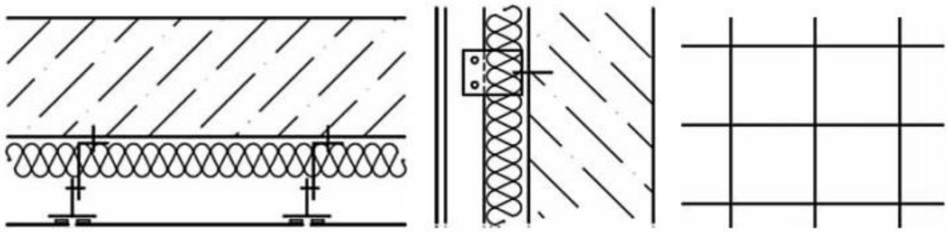
Plan Section Elevation

Figure 1.5 Installing sub-construction anchorages[13]



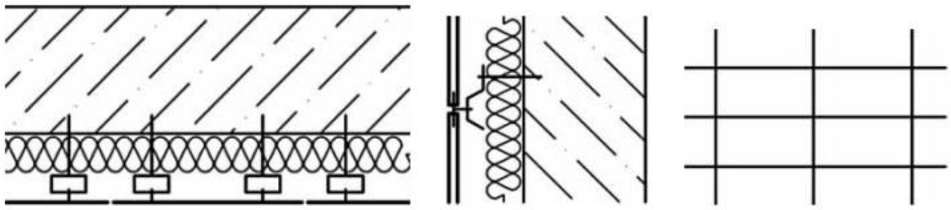
Plan Section Elevation

Figure 1.6 Installing sub-construction welding [13]



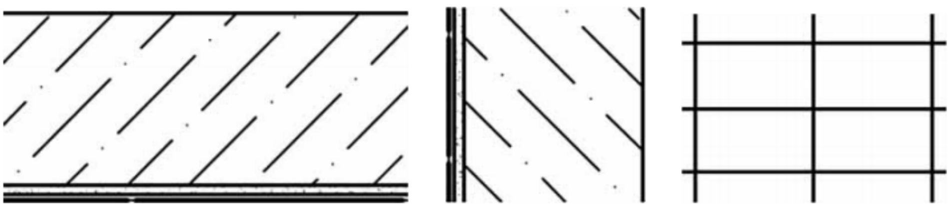
Plan Section Elevation

Figure 1.7 Installing sub-construction adhesive [13]



Plan Section Elevation

Figure 1.8 Installing wall core special anchorages [13]



Plan Section Elevation

Figure 1.9 Installing wall core adhesives [13]

1.8 Resisting bracket

Resisting brackets are made of various materials like polymer composites, Aluminium alloys and steel. Overlooking for the requirements of energy efficiency and fire safety, the most suitable material for brackets is steel [1].

The material and the form of the bracket have to maintain the acting loads in wall cladding.

1.9 Deformation of resisting bracket

Resisting bracket are also called as sub frame used in external wall cladding according to ETAG 034 the resisting bracket displacement changes in few years, because the load is constant in External wall cladding where, there is wind and loads given such a case all panels and building walls gets weak. The material life expectancy will be reduced.

1.9.1 Corrosion in resisting bracket

In external wall cladding the resisting bracket is a structural steel where, the material is used outside it easily gets corroded due to moisture in air, snow and rain. To avoid such a situation Zinc coating is applied on resisting bracket, but zinc is not a good bond of steel, the coating flake from the material in a short time.

1.10 Displacement changes and inducted loading

The strains and displacement in building components from anxieties created by stacking are all around perceived and are routinely managed in basic configuration. Be that as it may, other little dimensional changes occur in materials because of causes other than stacking. These may offer ascent to disfigurements, loads and anxieties that are not generally satisfactorily considered. Creep, a disfigurement with time under burden, and warm extension and compression are normally considered in the examination of the auxiliary edge, however they might be dismissed in the configuration of the divider itself. Dimensional changes may likewise come about because of changes in dampness content in specific materials and from maturing and debasing impacts delivered by environment. When these expansions or contractions are not restricted simply changes the element dimension. This in itself can often a problem. Example, a temperature differential of 100 degrees. steel or concrete results in dimensional changes of about 0.06 percent.

When they are constrained by the adjacent material or by an adjacent element, deformations and corresponding voltages can develop. a strain of only 0.01 percent to failure normal mass concrete in tension is necessary. A dimensional change of this magnitude can be produced by a temperature change of about 20 degrees. normal concrete blocks are reduced as much as 0.04 percent when dried from a saturated state. Fissures, cracks or buckling of the exposed surfaces or surface coatings often occur as a result of changes in temperature or humidity which promote either contraction or expansion. Once the cracks have developed severe wetting of the wall usually will follow. The results are not only from direct penetration of rain but also the condensation of water vapour carried in air leaks to the outside through the cracks [9].

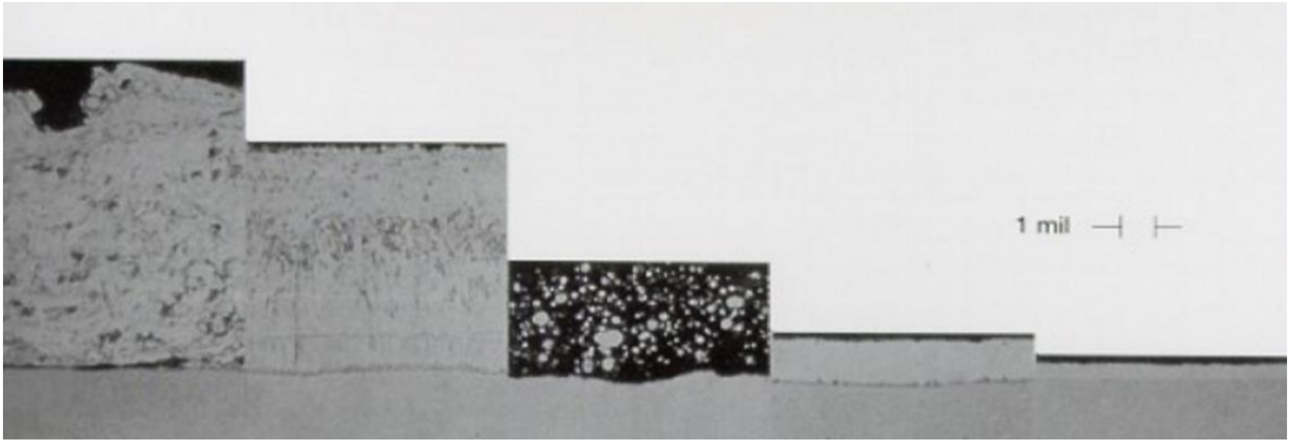
1.11 Coatings used in resisting bracket

Resisting bracket in external wall cladding needs coating due to weather conditions and moisture. In external wall cladding the resisting bracket holds the loads outside the building where it may get affected by atmosphere due to change in temperature and weather so the material gets corroded soon and also in cladding fixing the material is different by changing the material resisting bracket is made of structural steel where the tensile and yield strength is more and there is a dis advantage in the material where it gets corroded by the other end of the bracket aluminium rod is cladded with the bracket where the corrosion occurs due to different material. Thus, the coatings are used in the bracket to avoid all sort of problem occurs.

1.12 Zinc coating

Galvanization, or electrifying as it is most ordinarily brought in that industry. It is the procedure of applying zinc covering to steel or iron, to avert rusting. The most well-known technique is hot-plunge exciting, in which parts are submerged in a shower of liquid zinc.

Cluster hot-plunge electrifying, otherwise called general arousing, produces a zinc covering by totally drenching the steel item in a shower of liquid zinc. Before submersion in the zinc shower, the steel is synthetically cleaned to evacuate oils, soil, factory scale, and oxides. The surface arrangement comprises of three stages: degreasing to evacuate natural contaminants, corrosive pickling to evacuate scale and rust, what's more, fluxing, which restrains oxidation of the steel some time recently plunging in the liquid zinc. Surface planning is basic as the zinc won't respond with unclean steel.



Metallized Hot Dip Galvanized Zinc- Rich Paint Galvanized sheet Electroplated

Figure 1.10 Microstructures of different zinc coatings [21]

1.13 Methods of Zinc coating

Batch hot-dip galvanizing

It is also known as general galvanizing, produces a zinc covering by totally submerging the steel item in a shower (pot) of liquid zinc. Before submersion in the zinc shower, the steel is artificially cleaned to evacuate all oils, soil, plant scale, and oxides. Surface readiness is basic as zinc won't respond with unclean steel. there are two diverse fluxing strategies, dry and wet procedure is proficient by pre-fluxing in a zinc ammonium chloride Expulsion from Batch Galvanizing Bath arrangement. The wet procedure utilizes a liquid flux cover on the zinc shower surface.

Conditions

- Factory controlled
- Complete coverage
- Superior bond to steel
- Good for internal and exterior use.
- Coating is harder than the steel.

Continuous sheet galvanizing

It is also known as hot-dip process, but it is only applied to steel sheet, strip, and wire. The consistent hot-plunge covering procedure is a broadly utilized strategy initially created more than fifty years prior for exciting of items, for example, steel sheet, strip, and wire. the liquid covering is connected onto the surface of the steel in a consistent procedure.

Conditions

- Factory controlled
- Available in annealed condition for formability
- Mostly pure zinc coating – softer than steel
- Can be used only in Interior (unless painted is over)
- Precise and consistent coating thickness

Zinc painting

Zinc-rich paints ordinarily contain 92-95% metallic zinc in the film of the paint after it dries. e paints are connected by brushing or splashing onto steel cleaned by sand-impacting.

At the point when the zinc dust is supplied as a different part, it must be blended with a polymeric-containing vehicle to give a homogenous blend preceding application. Application is more often than not via air shower, albeit airless splash can likewise be utilized. e paint must be continually unsettled and the food line kept as short as could be allowed to forestall settling of the zinc dust. Uneven film coats may create if connected by brush or roller, and breaking may happen if the paint covering is connected too thick. Zinc-rich paints are named natural or inorganic, contingent upon the cover, and should be connected over clean steel.

Conditions

- Coating thickness consistency depends on skill of application
- Thinner coating on corners and edges
- In-shop or field application
- Durability depends on zinc content in dry film condition
- Weak bond to steel

Zinc spray metallizing

It is also called as metallizing, it can be applied on materials of different size, though structure is very important. They are commonly used an alternative to batch hot-dip galvanizing when the work piece is large. Zinc showering, or metallizing, is refined by bolstering zinc in either wire or powder structure into a warmed weapon, where it is softened and splashed onto the part utilizing ignition gasses or helper packed air to give the fundamental speed Heat for softening is given either by burning of an oxygen-fuel gas fire or by electric circular segment. Forms have been created for bolstering liquid zinc specifically into the shower spout, fundamentally for use in shop instead of field applications.

Conditions

- Factory controlled
- Quality varies by skill of labor
- Weak mechanical bond of zinc to steel
- Interior and exterior can be used
- Labor intensive

Mechanical plating

It consists of a coating flash of copper followed by zinc coating. Mechanical zinc plating is accomplished by tumbling small parts in drum with zinc and chemicals. Materials mechanically plated must be basic in configuration. Complex plans with breaks or visually impaired openings may not be altogether covered due to distance to the peening activity of the glass globules. It is additionally critical that the compaction specialists (glass dabs) are sufficiently extensive to abstain from being held up in any cavities, breaks, or little strings in the parts.

Conditions

- Small parts only
- Poor coverage in recesses
- Variable thickness coating depends on tumbling time
- Inconsistent coating thickness
- Thinner coating on edges and corners

Electro galvanizing

Electroplated coatings are created by applying zinc to steel sheet and strip by electro deposition. Electro-deposited zinc coatings consist of pure zinc tightly adherent to the steel. The coating is highly ductile remaining even after severe deformation.

Conditions

- Factory controlled
- Very thin/consistent coating
- Can be used only Interior
- Ductile coating on pure zinc
- Exposed steel edges when slit or cut-to-length.

Zinc plating

Ordinary zinc-plated coatings are dull dark with a matte completion, albeit more white, more glistening coatings can be delivered, contingent upon the procedure or specialists added to the plating shower or through post-medications. Zinc plating is ordinarily utilized for screws and other light latches, light switch plates, and different little parts. Materials for use in moderate or extreme situations must be chromate-transformation covered for extra erosion security. e covering is immaculate zinc, which has a hardness around 33% to one-a large portion of that of generally steels.

Conditions

- Small parts only
- Interior use only
- Very thin coating

2. METHODOLOGY

In this research work before analysing the material of resisting bracket, the material S 235 has taken for tensile test to find material it is linear or non- linear. Where the material properties are taken form the literature source [5,6] and are given in table 2.1.

Table 2.1 Properties of material of resisting bracket [6]

Material grade	Elastic modulus E N/m^2	Tangent modulus E_T N/m^2	Yield strength R_e N/mm^2	Tensile strength R_m N/mm^2	Poisson's ratio
S 235 structural steel	2×10^{11}	1.75×10^5	284	402	0.29

2.1 Tensile testing

The tensile test is a destructive test process that provides information on tensile strength, ductility and yield strength of a material. A tensile test, also known as tension test, is probably the most fundamental type of mechanical test can be performed on the material. Tensile tests are simple, relatively inexpensive, and fully standardized. Pulling something, you will quickly determine how the material will react to forces applied voltage. As the material is pulled, you will find its strength along with the amount that lengthen is shown figure 2.1 [15].

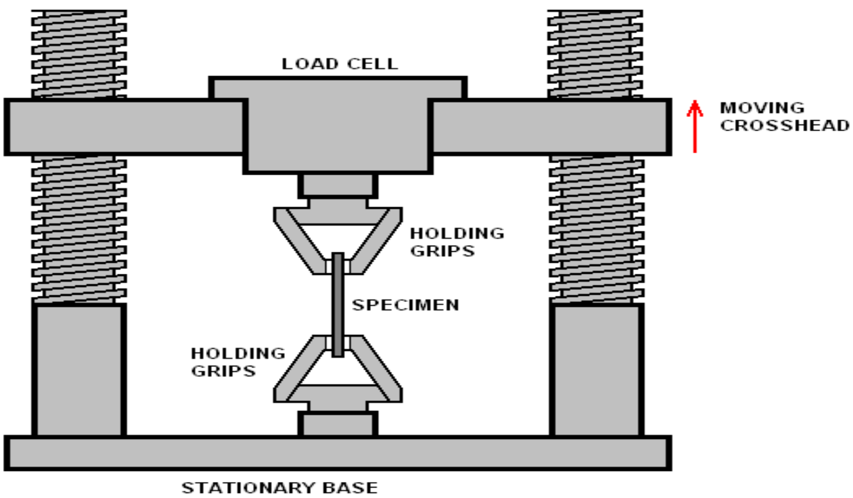


Figure 2.1 Tensile test machine [15]

Apparatus required

- Testing machine
- Force transducer
- Strain transducer
- Recorder
- Displacement transducer

2.1.1 Specimen preparation

In specimen preparation 10 specimen are prepared. Specimen are prepared by cutting the sheets 5 specimens has different stress and strain and other 5 specimen has different because specimen 5 was cut in horizontal and other five was cut in vertical. Dimensions of the specimen are shown in figure 2.2 and dimensions are given in table 2.2.

Table 2.2 Dimensions of the specimen

No. of specimen	Length, mm	Breadth, mm	Thickness, mm
10	90	20	2

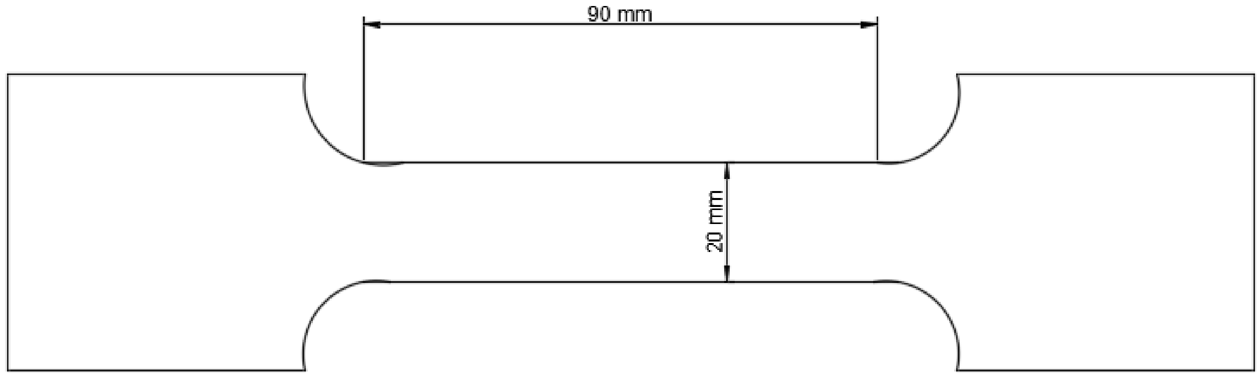


Figure 2.2 Example of Specimen

Procedure

The specimen which has both ends has to be fixed at both ends. Specimen is made of structural steel. Measure and record example measurements (distance across and gage length) accommodated the computation of the designing stretch and building strain. Denoting the area of the gage length along the parallel length of every example for ensuing perception of necking and strain estimation. Fit the example on to the all-inclusive Testing Machine and carry on testing. Record burden and expansion for the development of anxiety strain bend of each tried specimen.

Calculate stress and strain, of every example and record. Analyse the break surfaces of broken examples draw and portray the results. Discuss the test results and give conclusions.

Specimen Fixing

Tensile test machine which has both ends to fix the material vertically connected. Before the testing all values must be set in the computer. After data given transducer is connected to find young's modulus shown in figure 12.

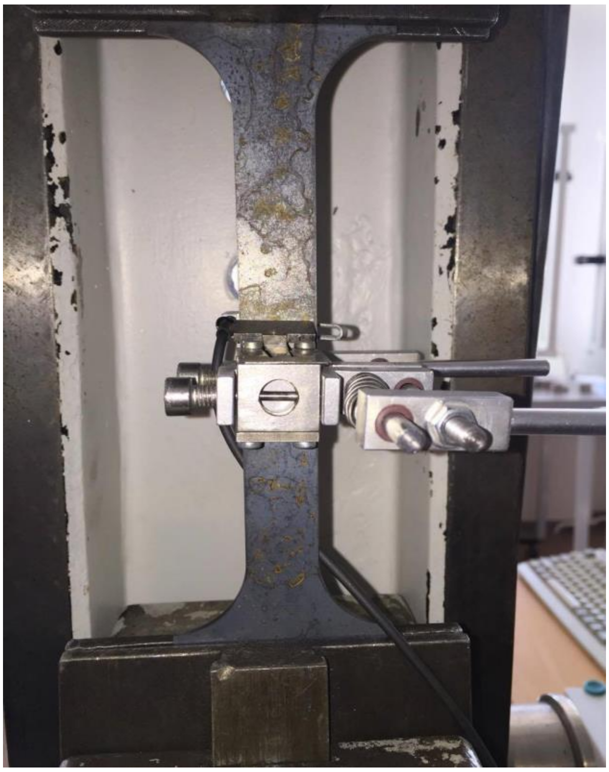


Figure 2.3 Specimen fixing

2.1.2 Tensile test calculations

Stress Calculation

$$\sigma = \frac{F}{A} \tag{2.1}$$

Engineering stress calculation

$$\sigma_e = \frac{F}{A_0} \tag{2.2}$$

Strain calculation

$$\varepsilon = \frac{\Delta L}{L_0} = \frac{L - L_0}{L_0} \tag{2.3}$$

where,

b_e=Engineering Stress

σ= Stress

L=Length

ΔL= change in length

$L_{0=}$ Initial length

2.2 Analyzing of resisting bracket

The resisting bracket was designed in solid works according to (ETAG 034) given dimensions after designing analysis is taken in Ansys software where, the material is non-linear analysis is taken in non- linear all material properties

Resisting bracket used in cladding is made up of steel S235. In this analysis bi-linear method is used for modelling of loading simulation in Ansys software [7].

2.3 Materials to be changed

In this analysis material is changed and load is given gradually to 0.3 mm, 1mm and 3mm displacement. The load varies for all three displacement values structural steel S 235 is the resisting bracket material used. In my analysis method three different materials are given and analysed. Steel alloyed 28CrS4 where the properties are given in table 5 [11]. Steel unalloyed 34CrNiMo6 is the second material used for analysis [12]. Finally, the structural steel S 460 N is analysed [13].

Table 2.3 Material Properties Structural steel material Properties [11,12,13]

Material grade	Elastic modulus N/mm^2	Tensile strength N/mm^2	Yield strength N/mm^2	Mass Density Kg/m^3	Poisson's ratio
Steel (alloyed) 28CrS4	210000	850	650	7800	0.28
Steel (unalloyed) 34CrNiMo6	210000	1200	1000	7800	0.28
Structural steel S 460 N	210000	530	380	7800	0.28

By changing resisting bracket material in external wall cladding material can get different results. The steel alloyed has more tensile strength and unalloyed steel has yield strength. Where elastic modulus, mass density and Poisson's ratio is common for all three materials.

For, analysing the bracket Ansys software will be used analysing the design improved bracket to compare the material strength for the wall cladding process with other materials. Each displacement is common for all materials load is compared for all three materials with older design structural steel S 235 material. Comparing all material could find the suitable material for cladding process.

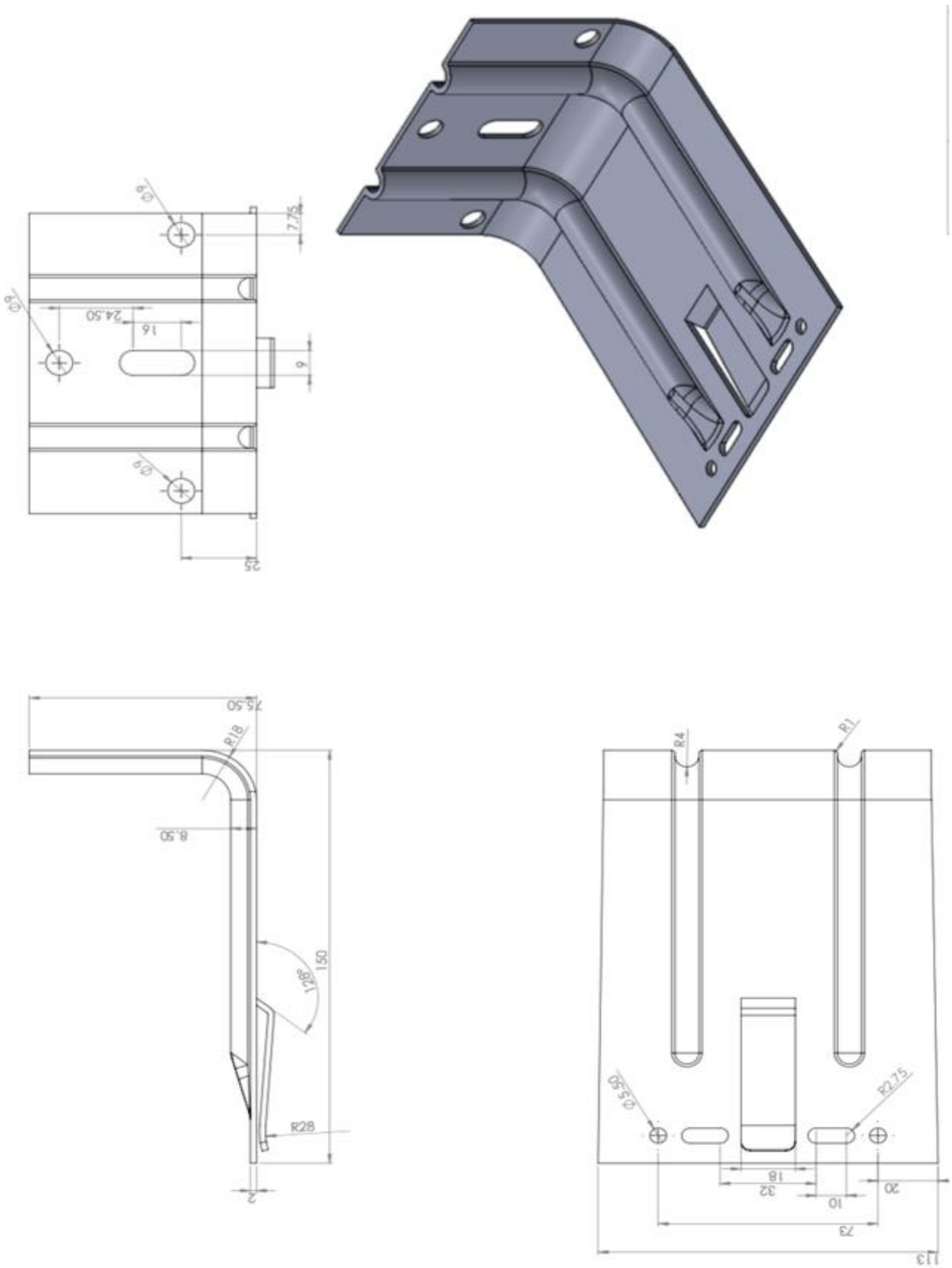


Figure 2.4 Design of resisting Bracket

2.3.1 Resistance of bracket calculations

ETAG 034 Calculations of resisting bracket

$$\Delta l = 0.2 \times L_x/100 \quad (2.1)$$

where,

L_x= Length of the wing

Δl = Displacement

2.4 Boundary conditions

Ansys software is used for the analysing resisting bracket by fixing for analysis which is shown in figure 15. In this analysis load is given in a vertical way is shown in figure 16. In figure 17 both are shown because default bracket and design improved bracket has same fixing and load direction which are given on screws.

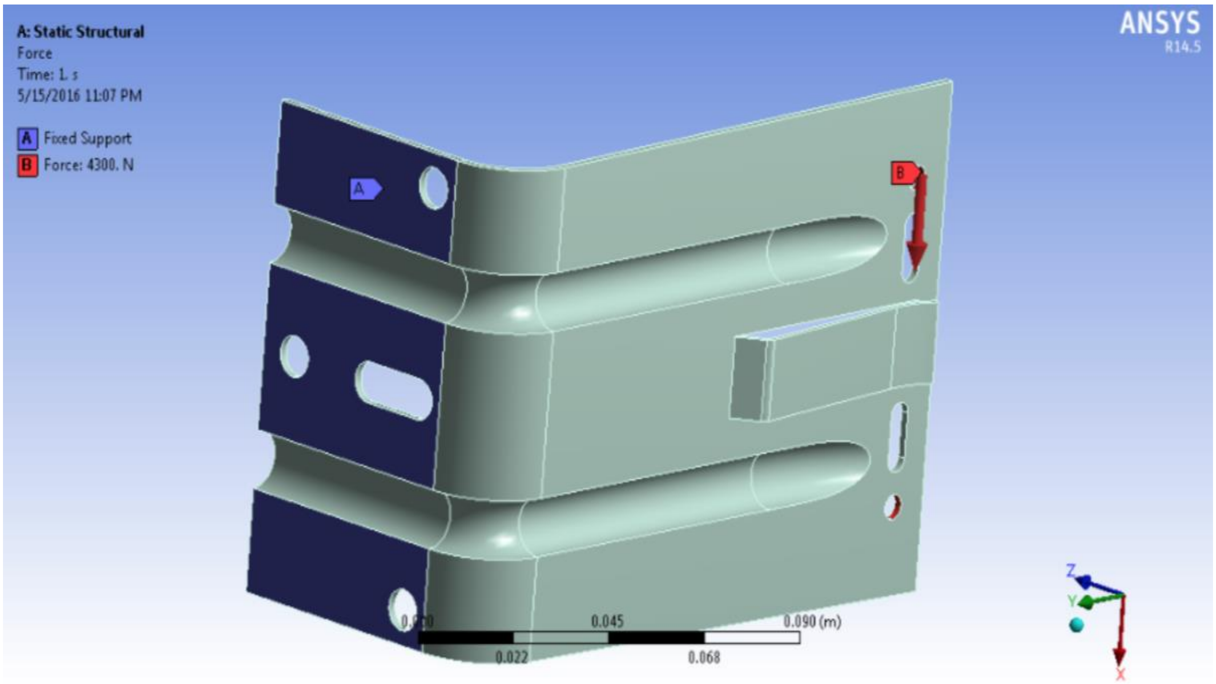


Figure 2.5 Old design resisting bracket

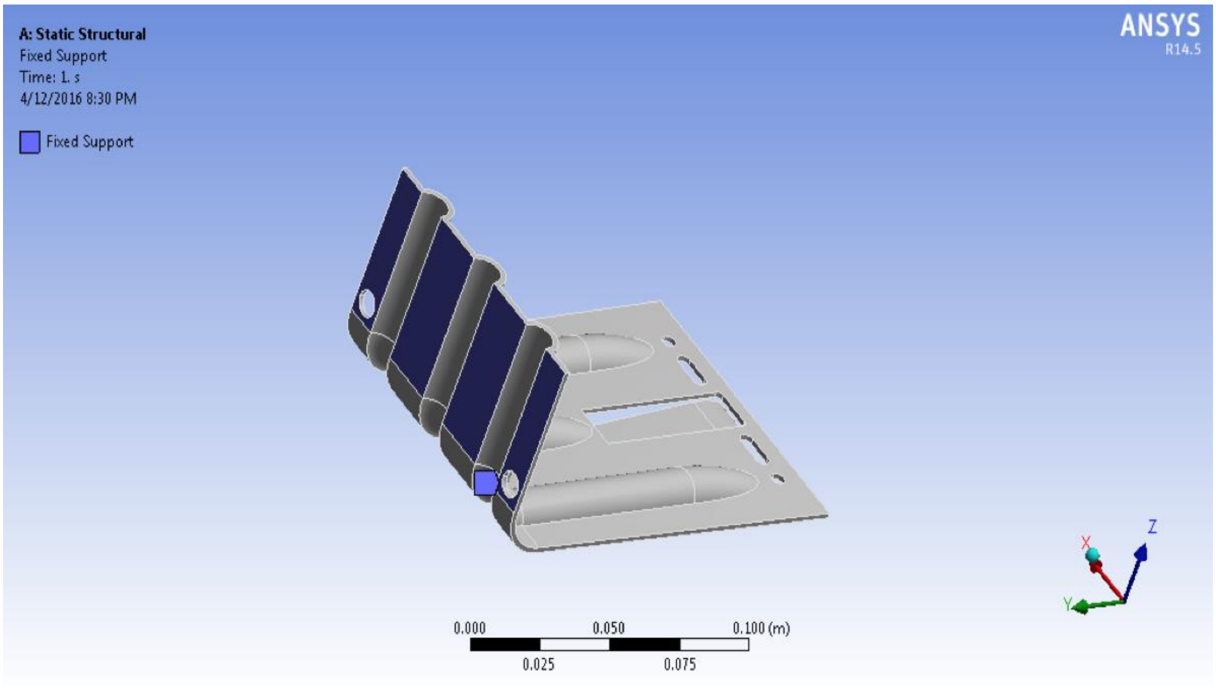


Figure 2.6 Fixing of resisting bracket

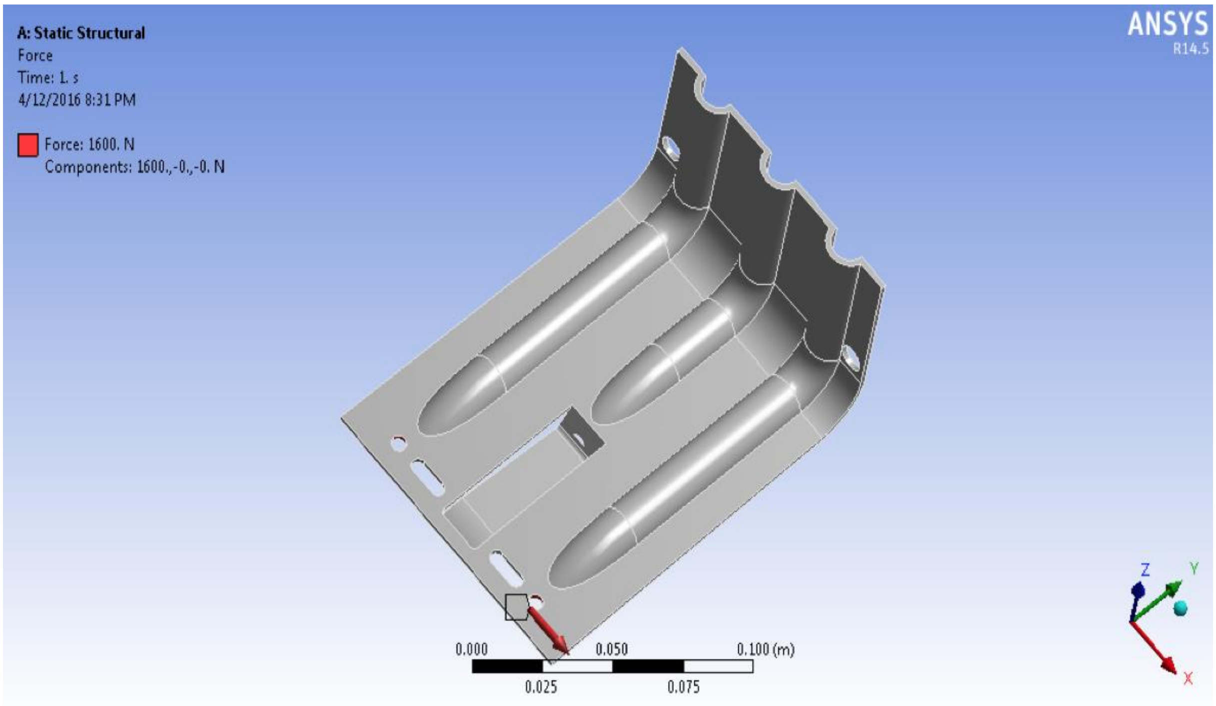


Figure 2.7 Load given direction

2.5 Resisting bracket corrosion

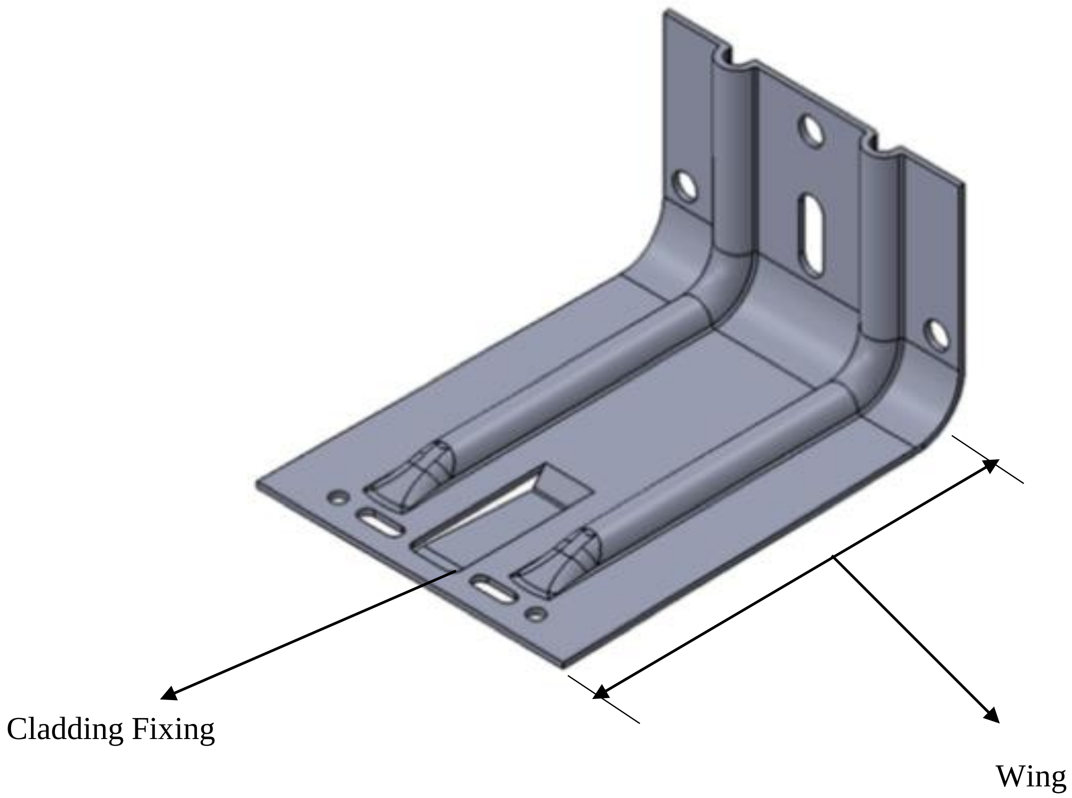


Figure 2.8 resisting bracket used in external wall cladding

Resisting bracket is a structural steel S 235 grade were used in wall cladding. In this bracket one end is fixed in wall with screws and bolts and the other end of the bracket cladding process is done where cladding rod is cladded with a clamp screws and bolts shown in figure 2.8. Corrosion occurs due to weather, atmosphere and also due to steel and aluminium rod cladding fixing.

while cladding fixing process aluminium rod is cladded with resisting bracket clamp screws and bolts in such a case weather and temperature changes chemical reactions takes place. Material gets corroded quickly due to this resisting bracket life is reduced an wall cladding gets damages of this process.

3. RESULTS AND DISCUSSION

3.1 Tensile test results

The structural steel S235 is used for analysing. The material after analysing is found that the material is non-linear by plotting stress and strain curve.

Figure 3.1 Example of Tensile tested specimen

3.2.1 Tensile test Calculations

Example of tensile test Specimen 1

Stress

$$\sigma = \frac{F}{A} \tag{3.1}$$

= 0.468/40

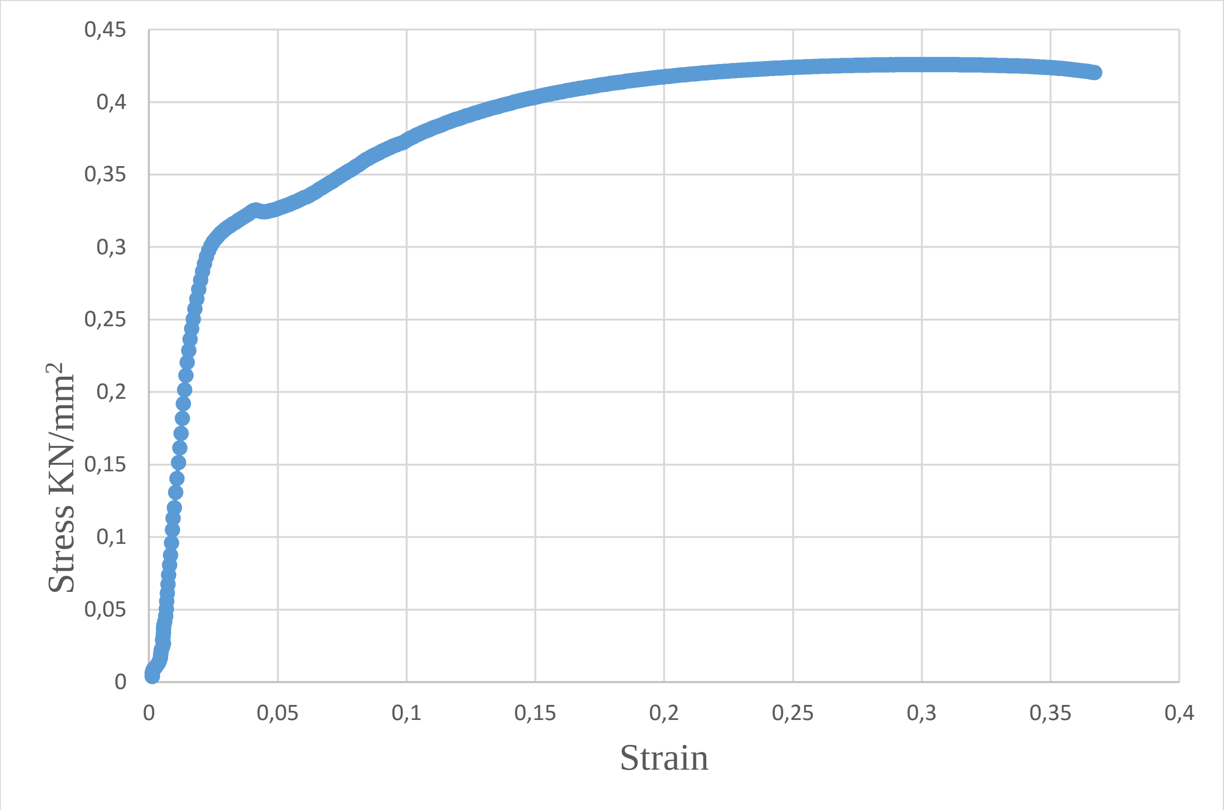
= 0.0117

Strain

$$\varepsilon = \frac{\Delta L}{L_0} = \frac{L - L_0}{L_0} \tag{3.2}$$

= 1.159375/90

= 0.012882



Graph 3.1 Stress and strain curve of S235

3.2 Resisting bracket calculations

In this calculation displacement is found by calculation using length of the wing according ETAG 034.

Calculations of resisting bracket

$\Delta l = 0.2*L_x/100$ (3.3)

L_x= Length of the wing

= 150 mm

= 0.2*150/100

Δl = 0.3 mm is the displacement.

Where we can find the displacement changes by increasing the load.

These calculations are calculated according to ETAG 034

3.3 Design improvement

The design of resisting bracket was improved by introducing a third stiffening rib at the centre of bracket. The simulation of loading of the bracket was made according standard ETAG 034 Part II [8]. After analysing the resisting bracket in Ansys software, deformation changes due to a new design of the bracket. Here load is gradually increased and comparison of the deformation of old and new designs of brackets were performed show in figure

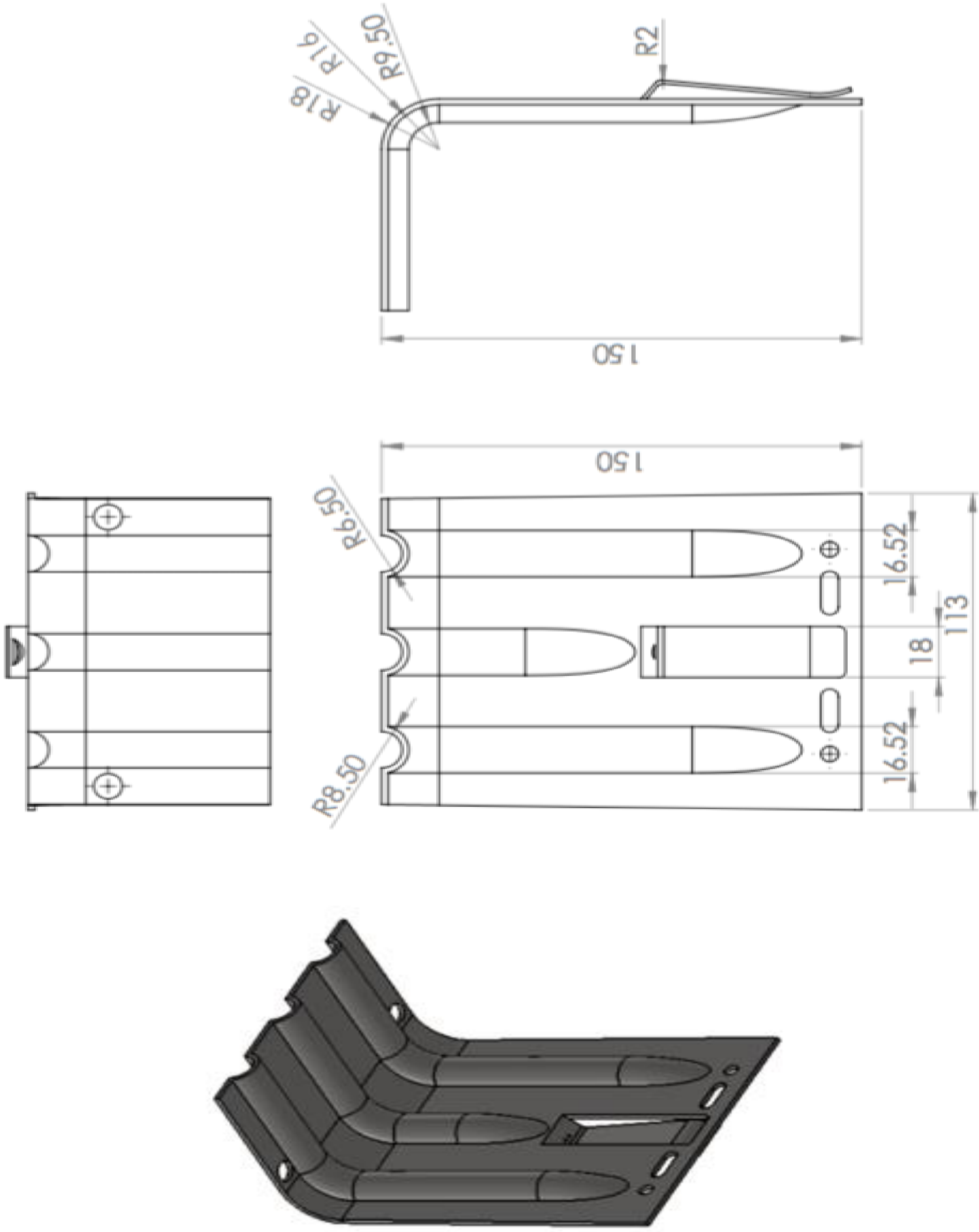
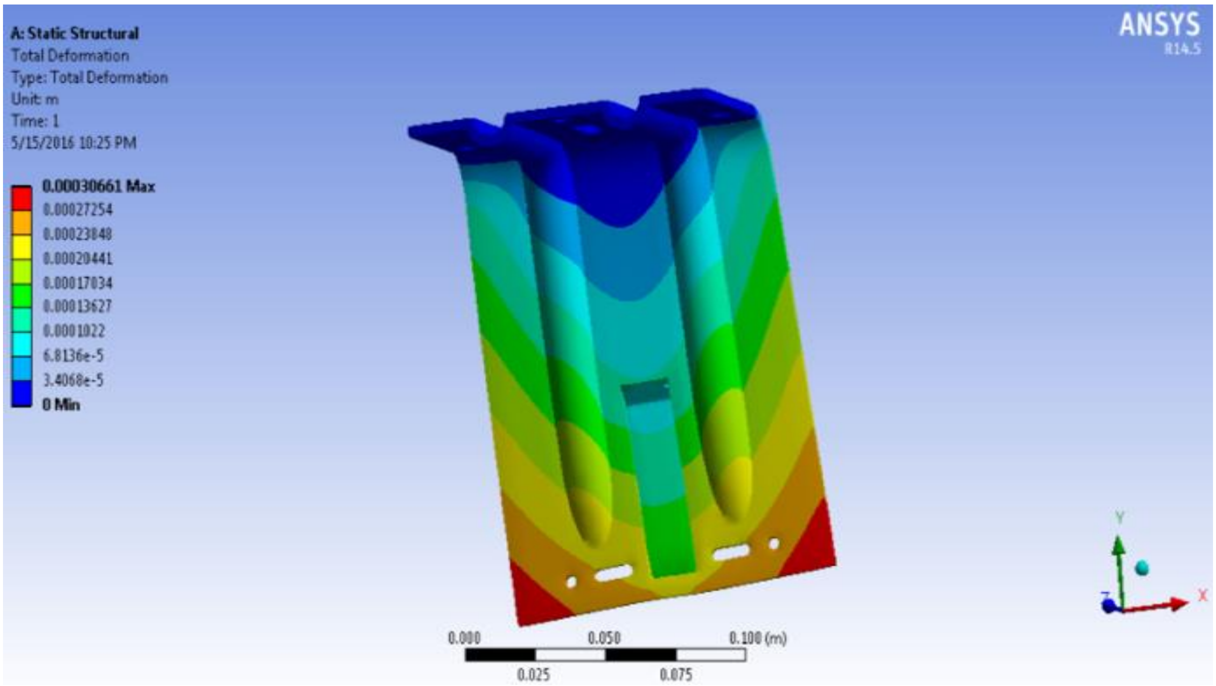


Figure 3.2 Resisting bracket after improvement of design

3.4 Analyzed results of resisting bracket

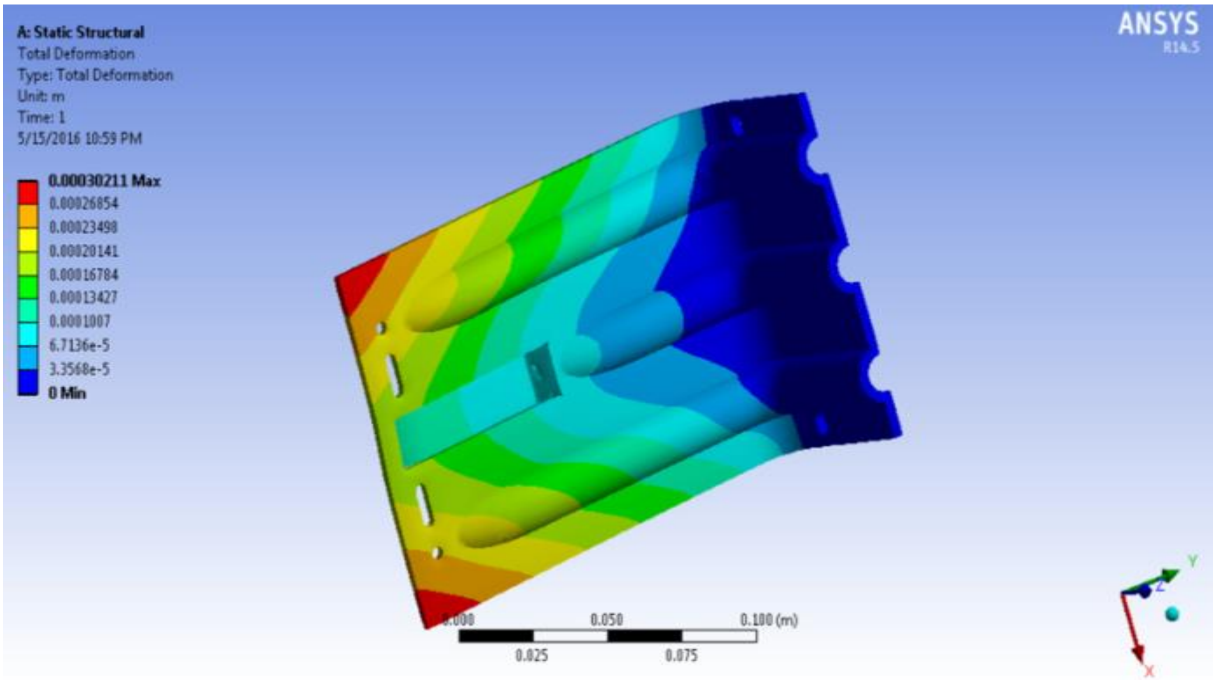
Analysed results by comparing both default and design improved resisting bracket by setting up displacement values 0.3 mm, 1mm and 3 mm are calculated from ETAG 034 guidelines. According to ETAG 034 the values are taken and solved.

All analysis method is followed in Ansys software using bi-linear method. In this analysis non – linear method. In this analysis the material S 235 material properties like yield strength, tensile strength and mass density are given in Ansys software. Bi-linear method gives normal representation of metal plasticity. Thus, the analysis is followed load is gradually increased in both analysis and compared both results.



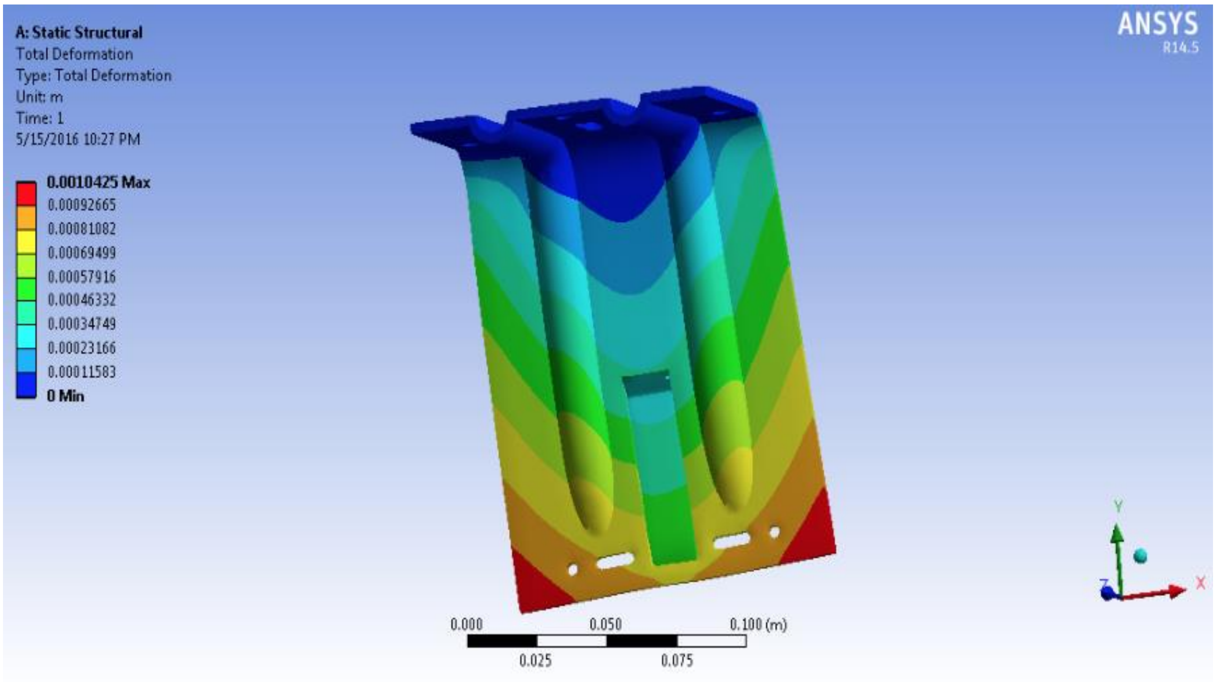
(a)

Analysing in Ansys software bracket one side is fixed and the other side load is given in horizontal way in bolt and the loads are given gradually according ETAG 034 guidelines.

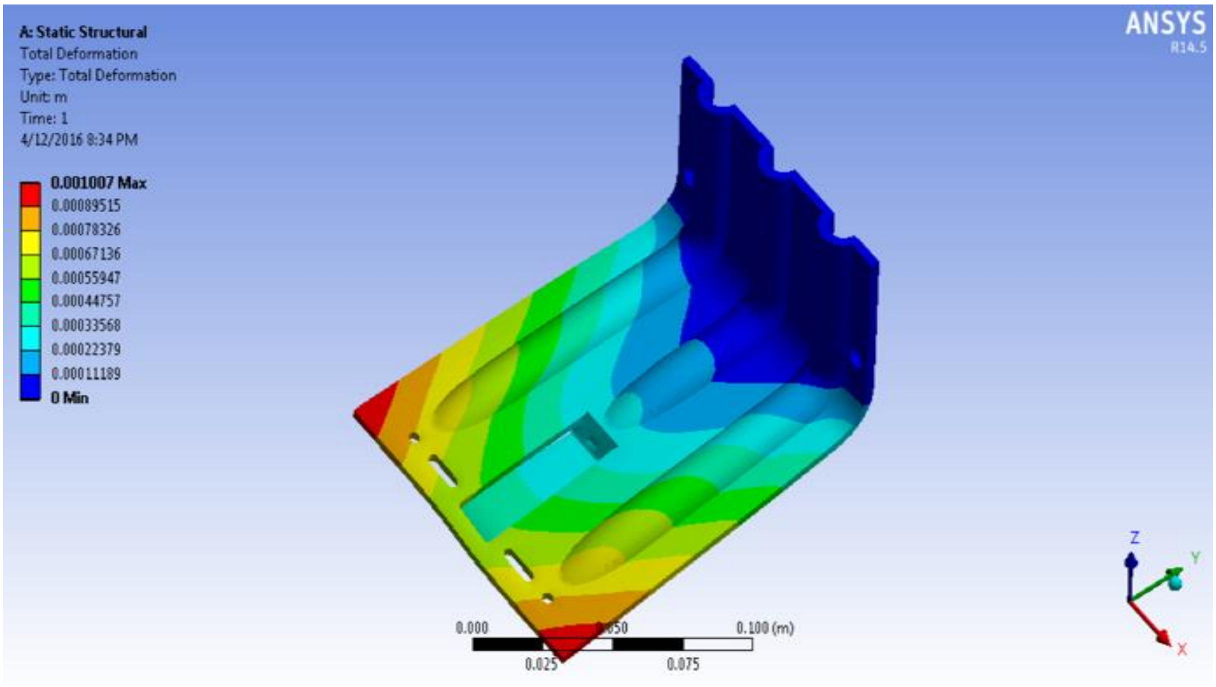


(b)

Figure 3.3 Modelling of deformations before (a) and after (b) design improvement 0.3 mm

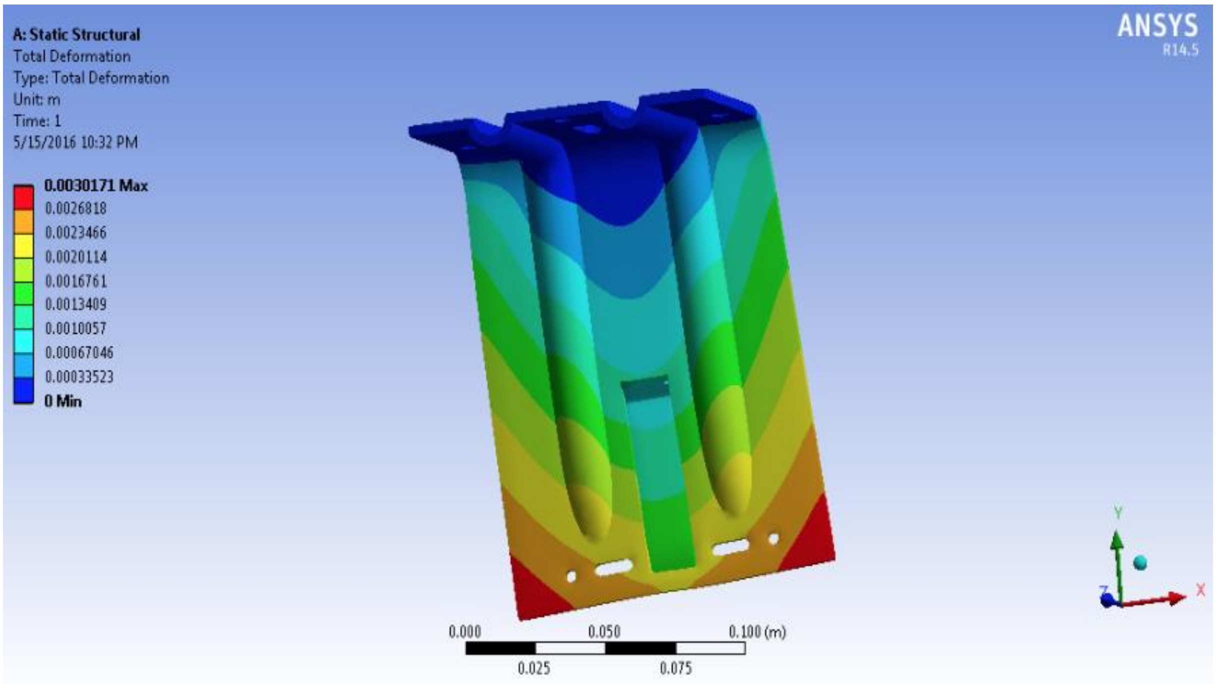


(a)

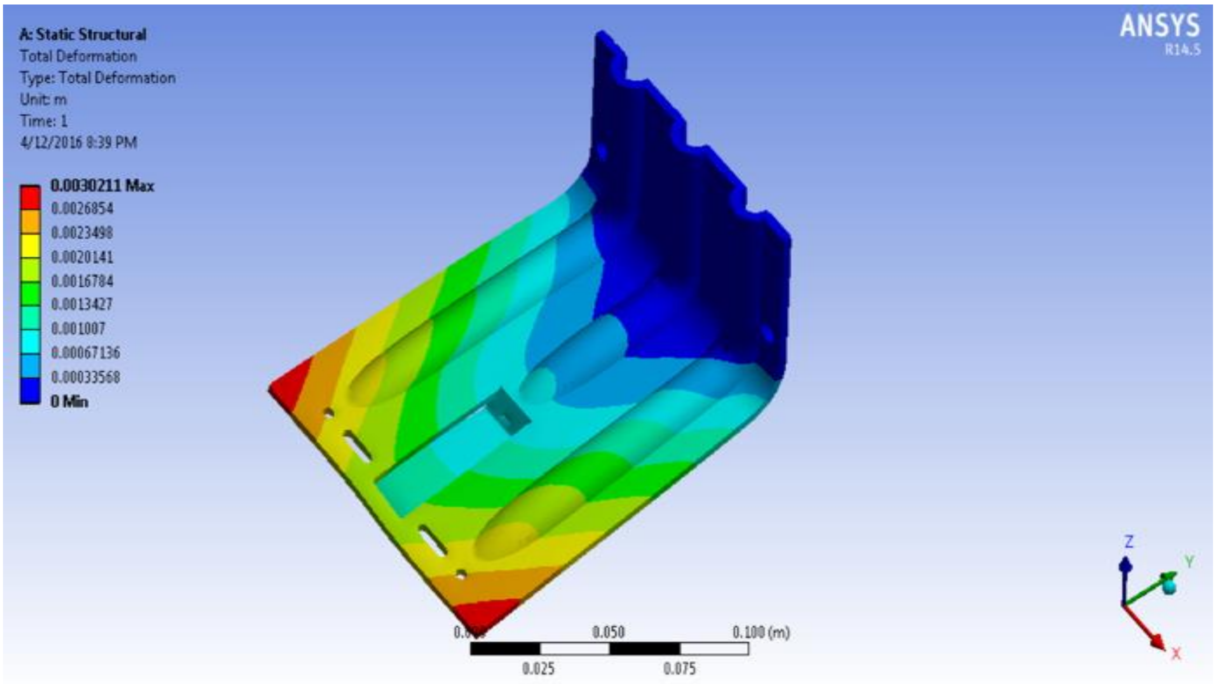


(b)

Figure 3.4 Modelling of deformations before (a) and after (b) design improvement 1 mm



(a)



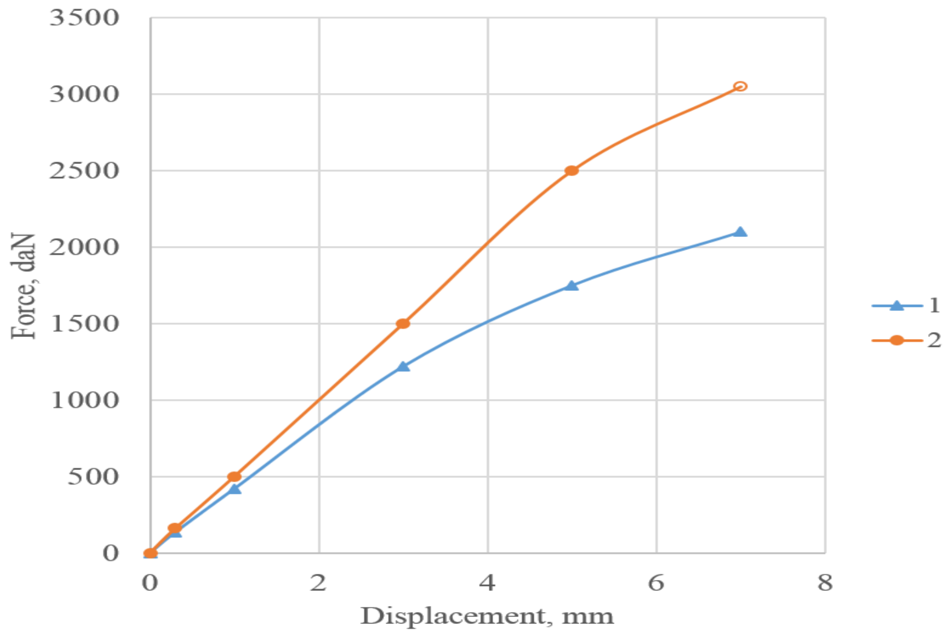
(b)

Figure 3.5 Modelling of deformations before (a) and after (b) design improvement 3 mm

According to the calculated results new design of the bracket can withstand more load than the old bracket. Where we can see the load increases compared to the other. Increasing the bracket strength and more loads can be loaded.

Table 3.1 Acting loads at certain displacement calculated by Ansys software

Displacement, mm	Specified loads for original design of bracket, daN	Specified loads for improved design of brackets, daN
0.3	150	160
1	420	500
3	1220	1500



Graph 3.2 Comparison of resistance of bracket: 1- before improvement; 2- after improvement

3.5 Material changed results

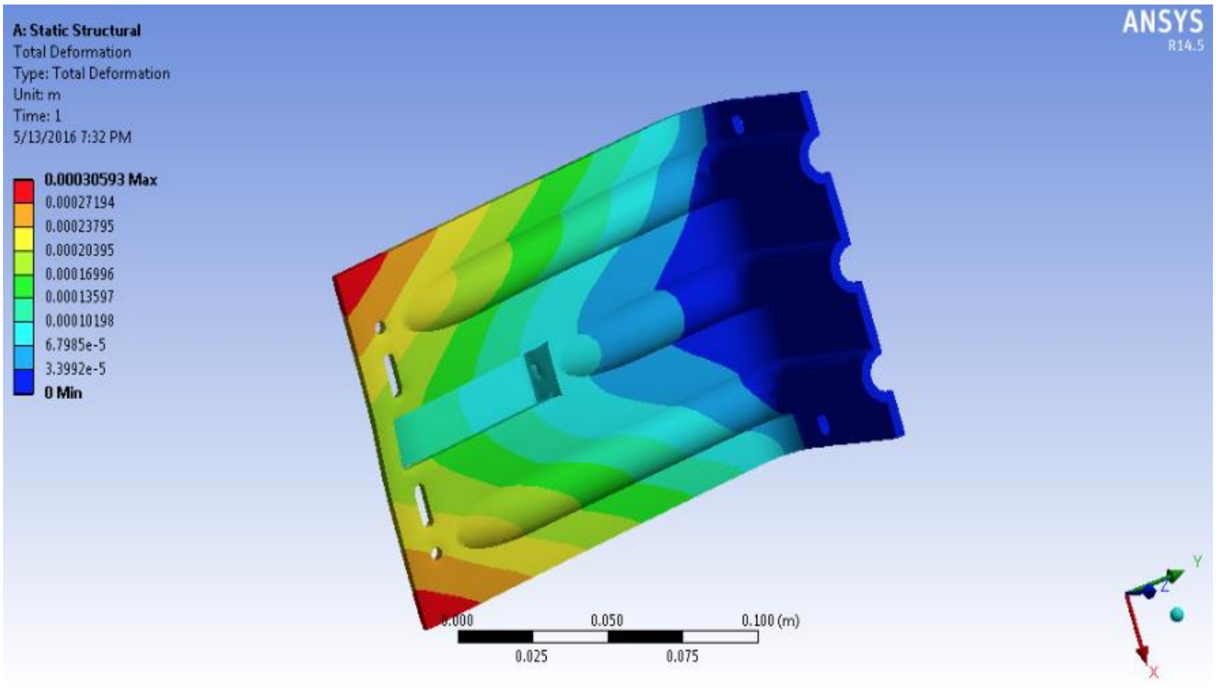


Figure 3.6 Deformation 0.3 mm unalloyed steel 34CrNiMo6

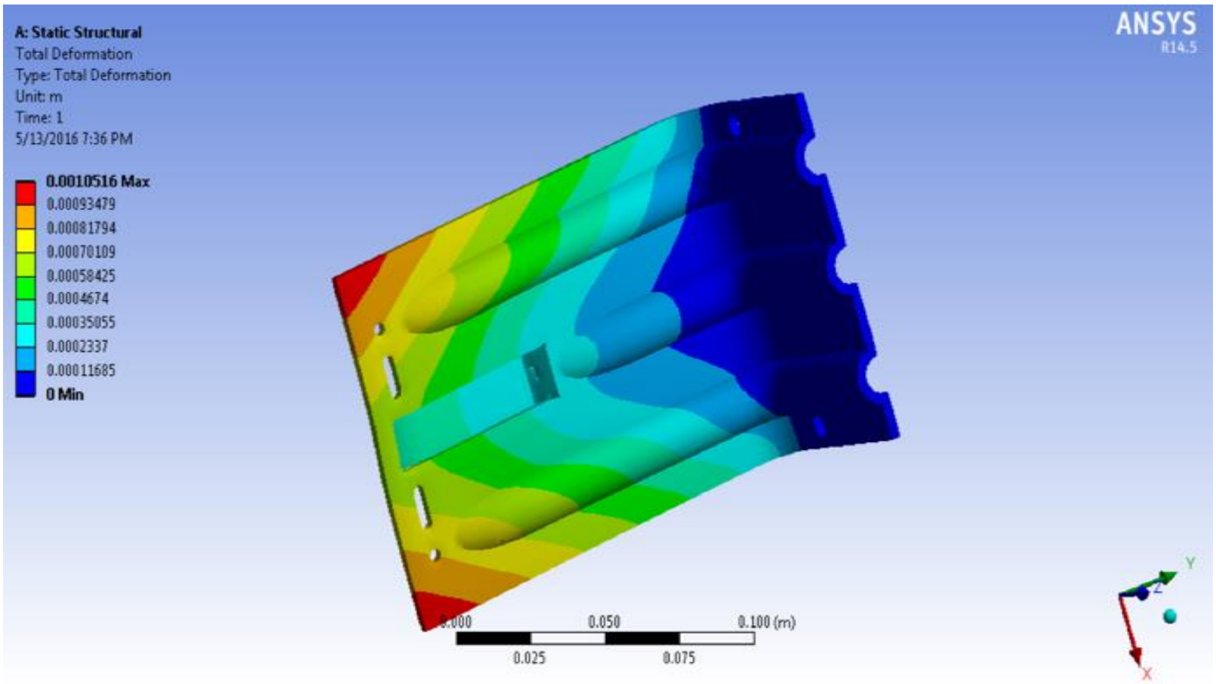


Figure 3.7 Deformation 1 mm unalloyed steel 34CrNiMo6

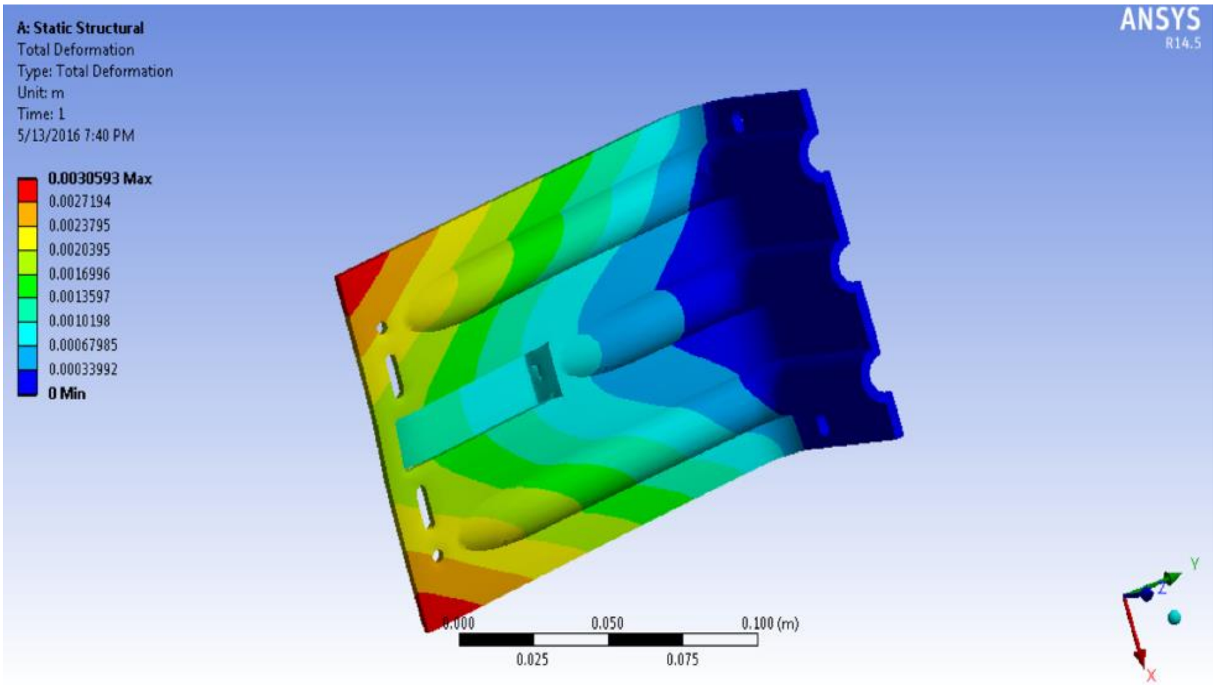
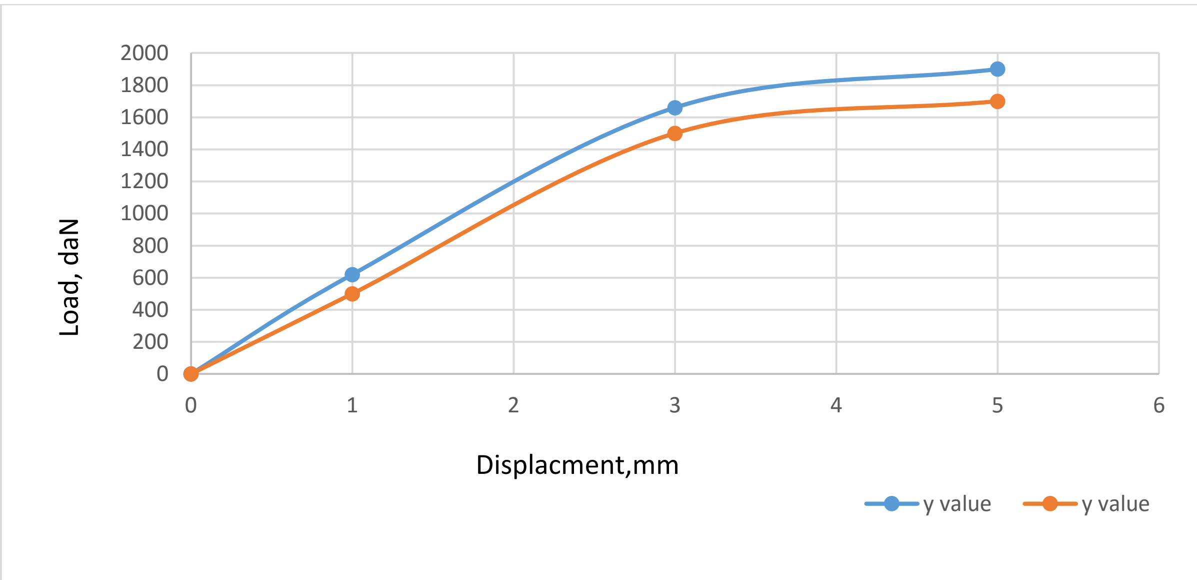


Figure 3.8 Deformation 3 mm unalloyed steel 34CrNiMo6

Table 3.2 Acting load displacement compared with steel 34CrNiMo6

Displacement mm	Specified loads for Steel (unalloyed) 34CrNiMo6 daN	Specified loads for Structural steel S 235 daN
0.3	160	160
1	600	500
3	1660	1500



Graph 3.3 comparison the results between blue value un alloyed steel and orange value colour structural steel

3.6 Structural steel S460N

Analysing the structural steel S460 N with the other steel S235 default resisting bracket used in external wall cladding.

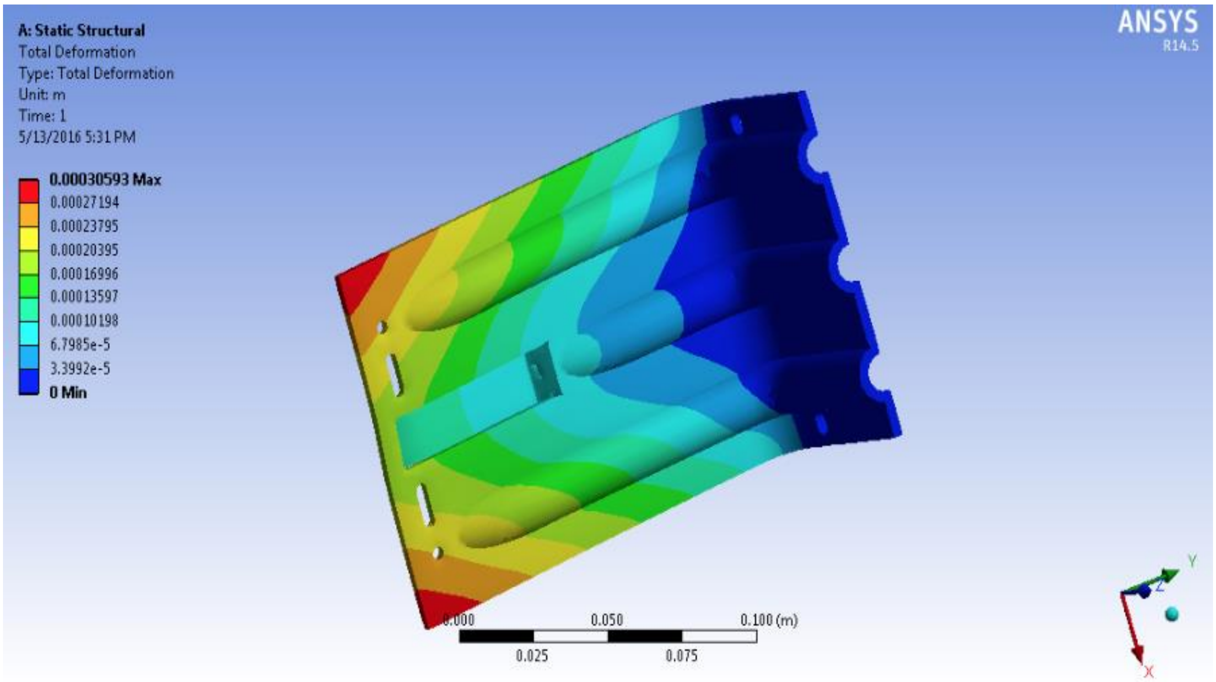


Figure 3.9 Deformation 0.3 mm structural steel S460 N

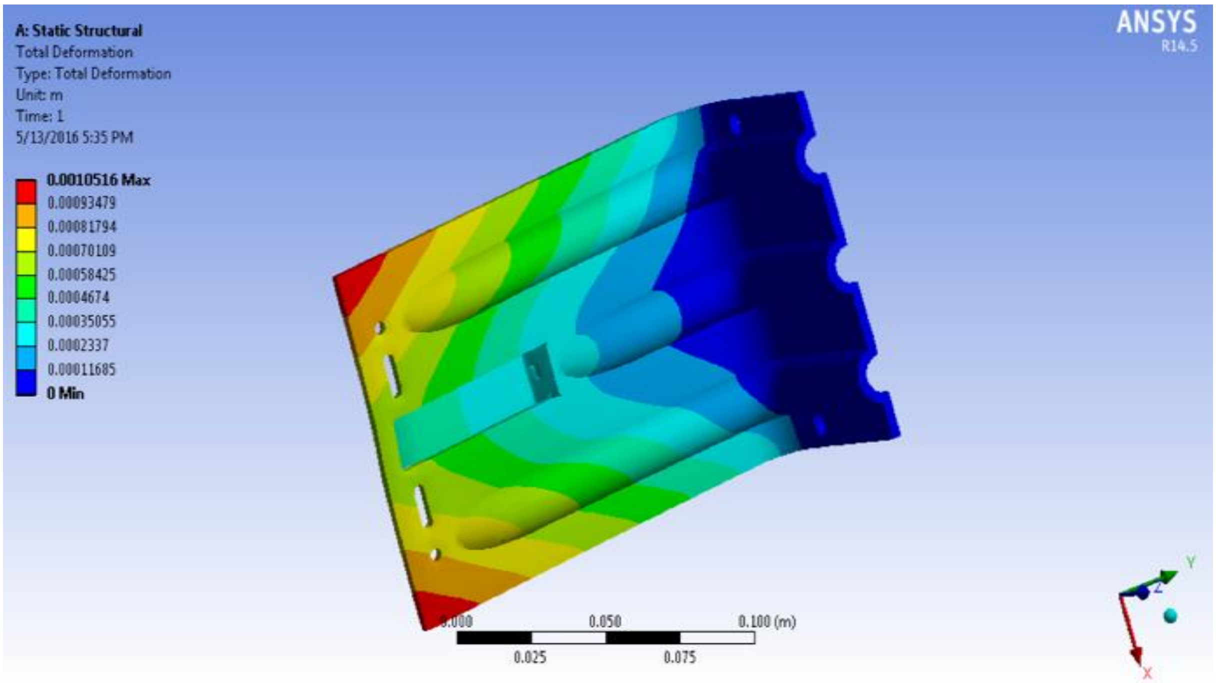


Figure 3.10 Deformation 1mm structural steel S460 N

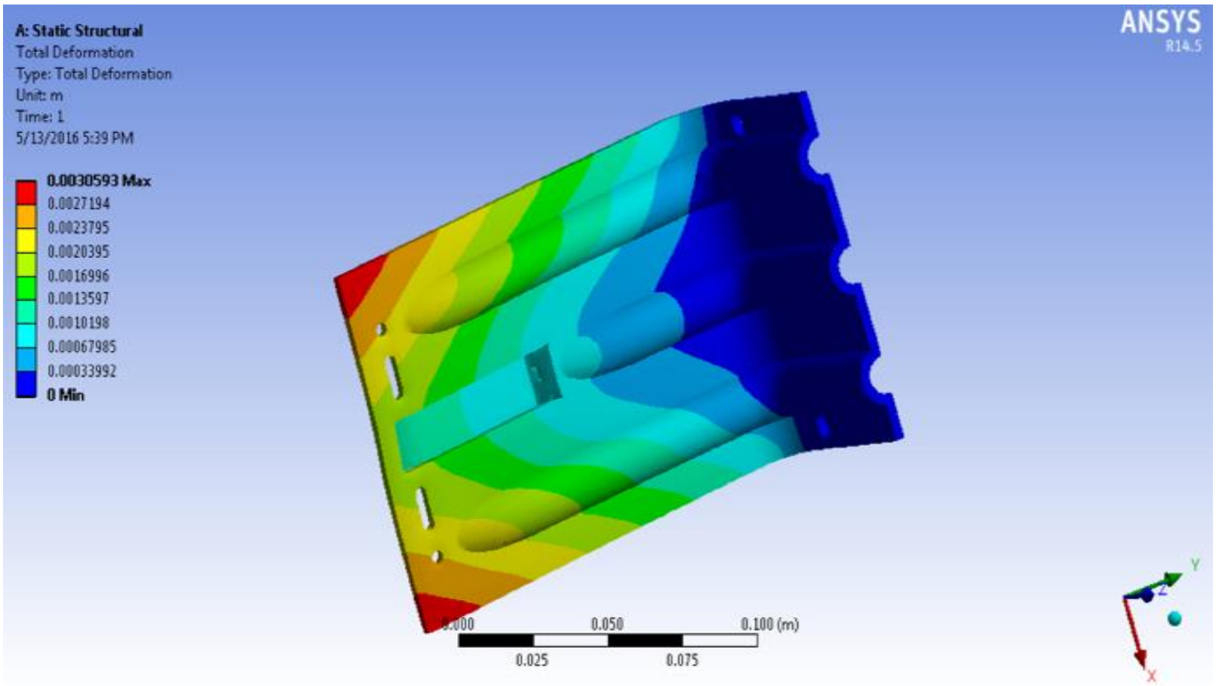
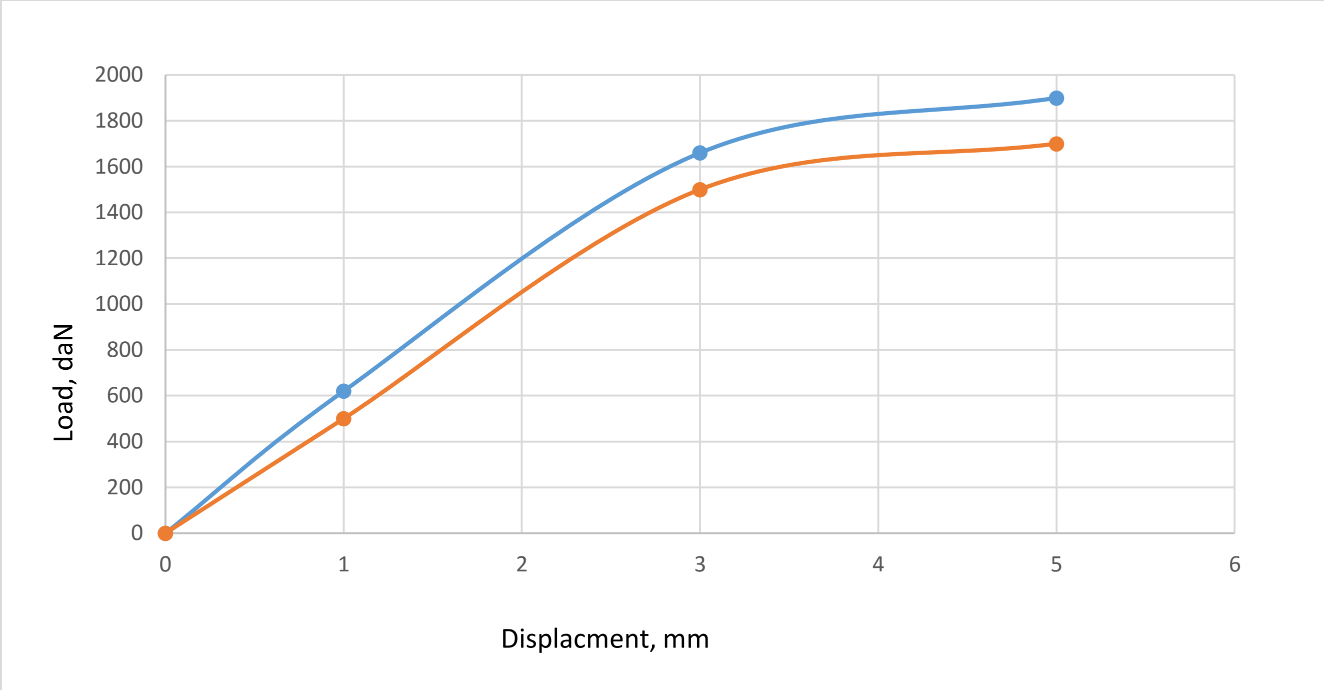


Figure 3.11 Deformation 3 mm structural steel S460 N

Table 3.3 Acting load displacement compared with steel S 460 N

Displacement mm	Specified load for structural steel S 460 N daN	Specified load for structural steel S 235 daN
0.3	160	160
1	624	500
3	1663	1500

Comparing structural steel S 235 and structural Steel S 460 N for displacement value 0.3 mm load is common for both material. Displacement 1 and 3 load value varies for both materials shown in table 3.3.



Graph 3.4 comparison between blue value alloy steel and orange value structural steel

3.7 Steel (alloyed)

Material used in this analysis is steel which is alloyed grade-28CrS4

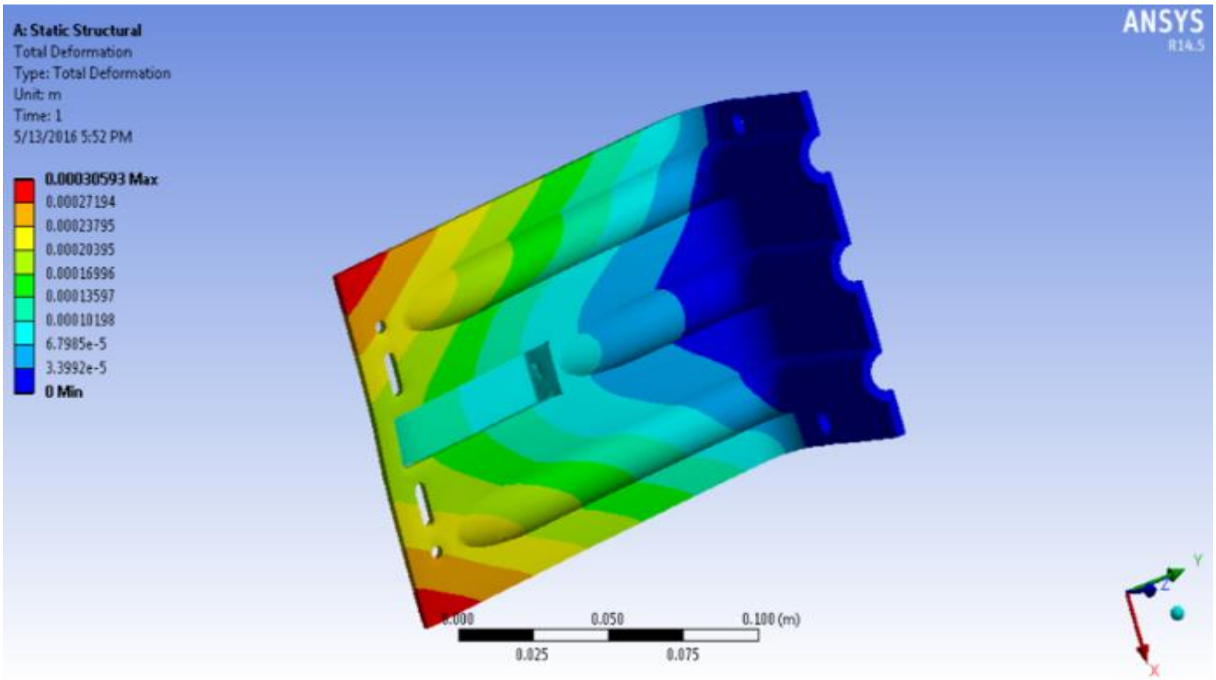


Figure 3.12 Deformation 0.3 mm alloyed steel 28CrS4

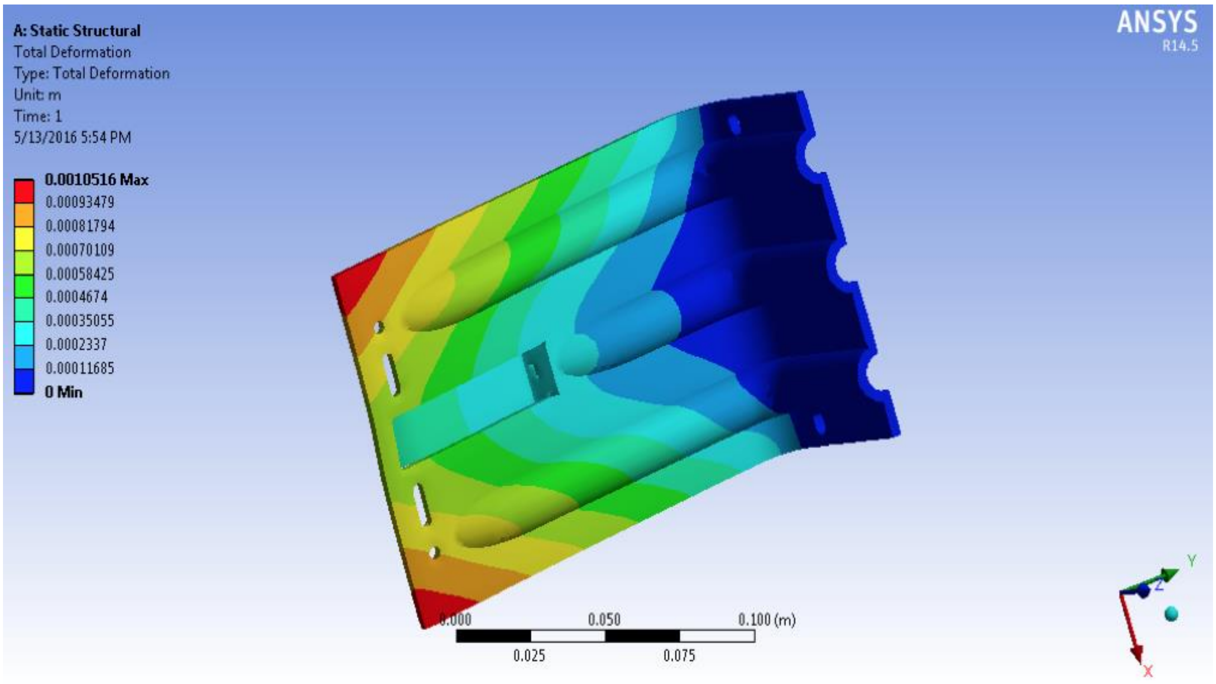


Figure 3.13 Deformation 1 mm alloyed steel 28CrS4

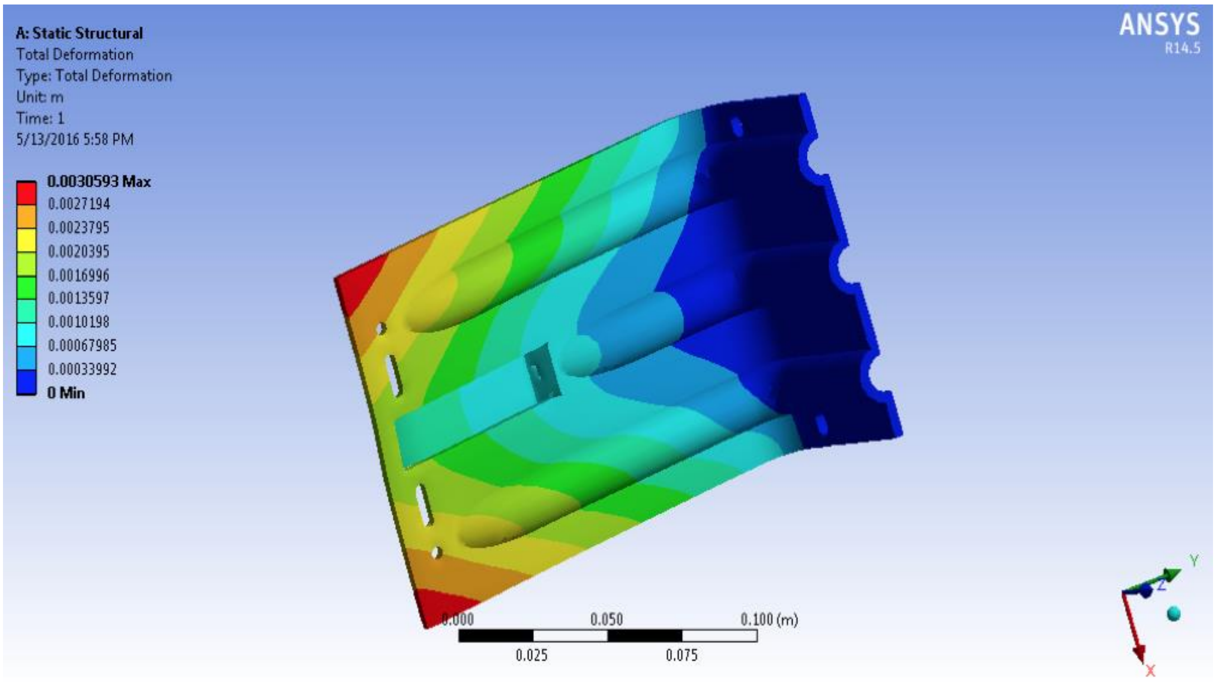
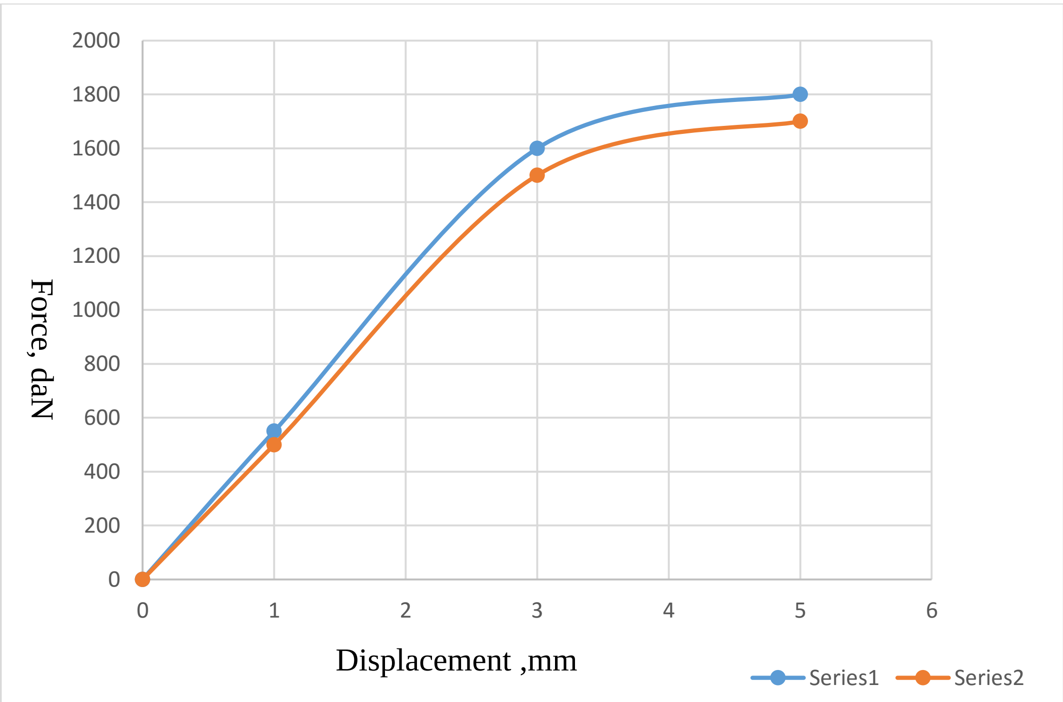


Figure 3.14 Deformation 3 mm alloyed steel 28CrS4

Table 3.4 Acting load displacement compared with steel 28CrS4

Displacement mm	Specified loads for Steel (alloyed) 28CrS4 daN	Specified loads for Structural Steel S 235 daN
0.3	160	160
1	550	500
3	1600	1500

By analysing resisting bracket with three different materials with Ansys software. The results are different compared to S 235 material.



Graph 3.3 Comparison of resisting bracket 1- S 235 steel 2- 28CrS4 steel alloyed

3.8 Steel bracket coatings

In resisting bracket to control corrosion, zinc coating is used but the coatings flake from material due to weak bonding of zinc and steel. By analysing different journal to increase the bonding between steel and zinc Two-component epoxy resin/zinc dust priming coat for steel surfaces by using epoxy resin /zinc bonding is theoretically improved.

4. CONCLUSION

1. Stress and stain curve is obtained in tensile test machine where we used 10 specimens for the tensile test. Five specimen where cut in horizontal and five was in vertical cut from the sheets.

2. Therefore, the design of the bracket is improved by improving the material strength is increased up to 20 % and also withstand more loads compared to the older design of the bracket a rib is implemented in the resisting bracket and is designed in Solid works software.

3. Designed bracket has to be compared to old and the new design. For, Analyzing the bracket is taken in Ansys software where the bi linear method is followed and non – linear analysis is used and we get values of deformation, stress and strain and compared the difference by load acting in the bracket.

4. All the dimensions are taken from ETAG 034 guidelines and all analysis is followed from the guidelines. Three different materials like alloyed steel, un alloyed steel and structural steel with other grade which has more tensile and yield strength compared to older bracket are used for analyzing with design improved bracket and found the suitable material for cladding insulation.

5. Corrosion occurs in the bracket can be solved by adding epoxy resin in the zinc coating increases the bonding between zinc coating with the steel. The flakes from zinc coating is also reduced.

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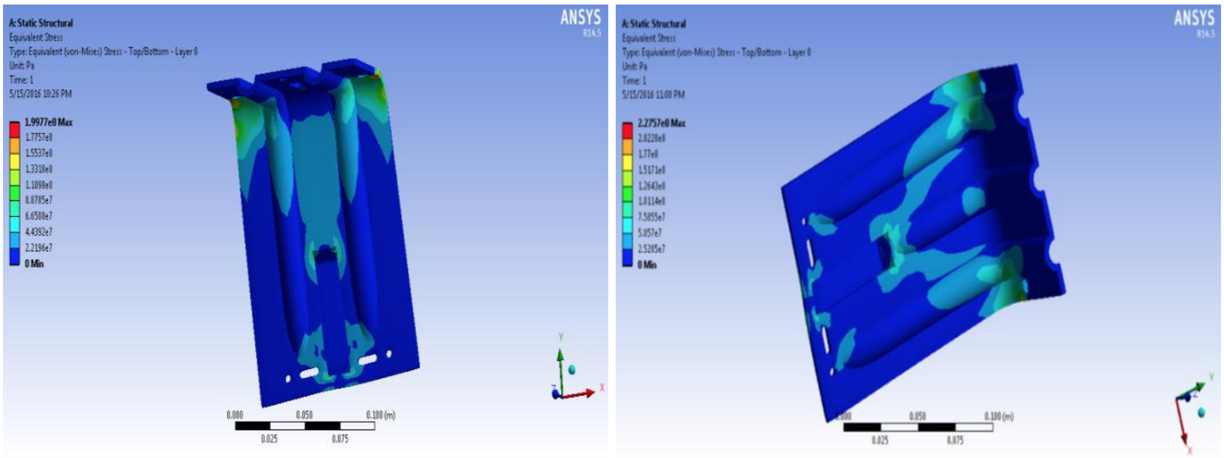
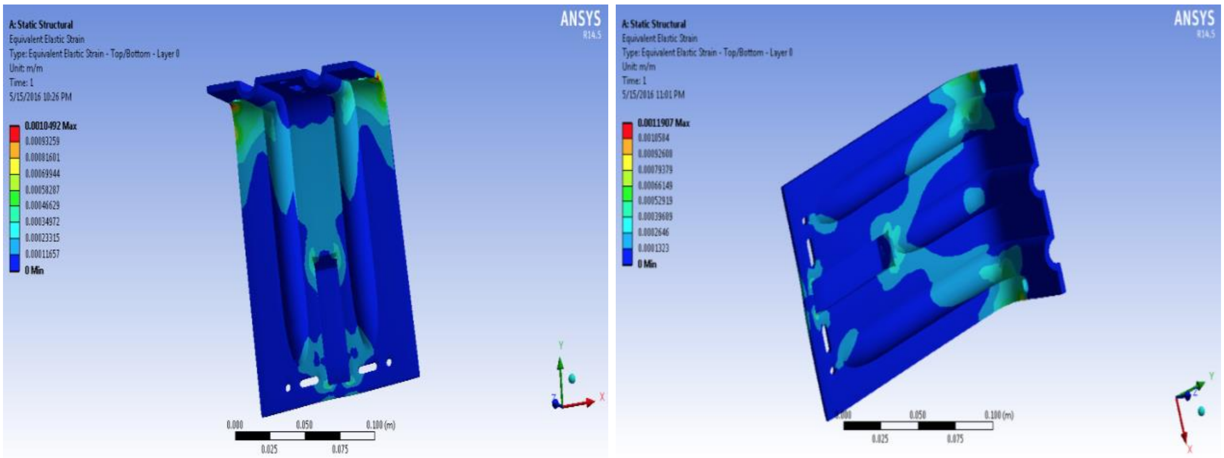
6. APPENDIXES



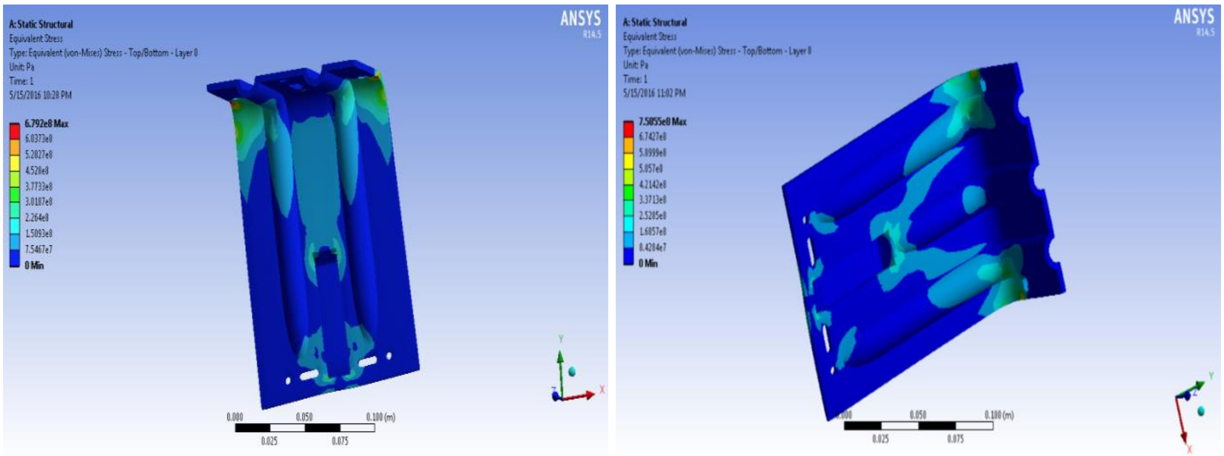
a b

Modelling of Stress before (a) and after (b) for 0.3 mm resisting bracket



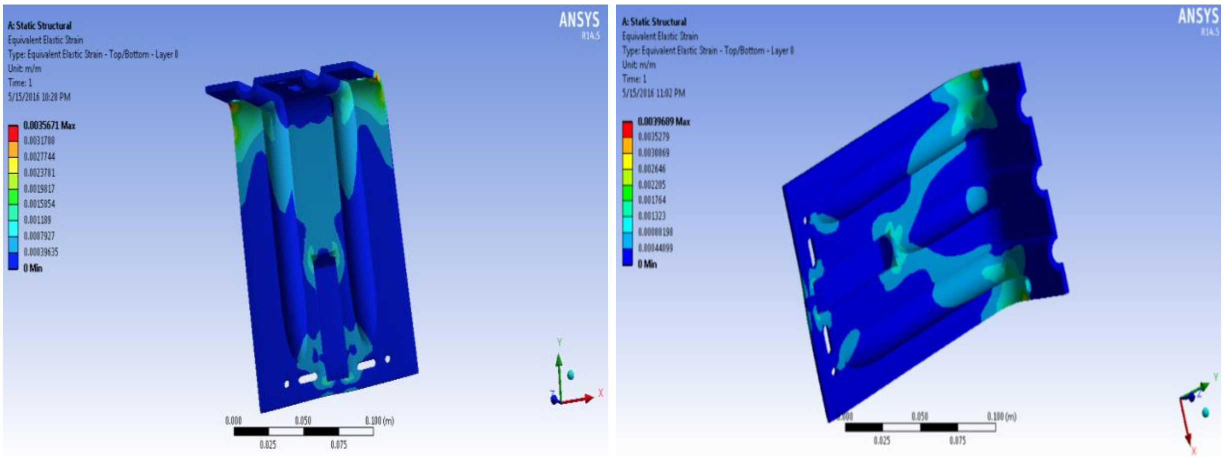
a b

Modelling of Strain before (a) and after (b) for 0.3 mm resisting bracket



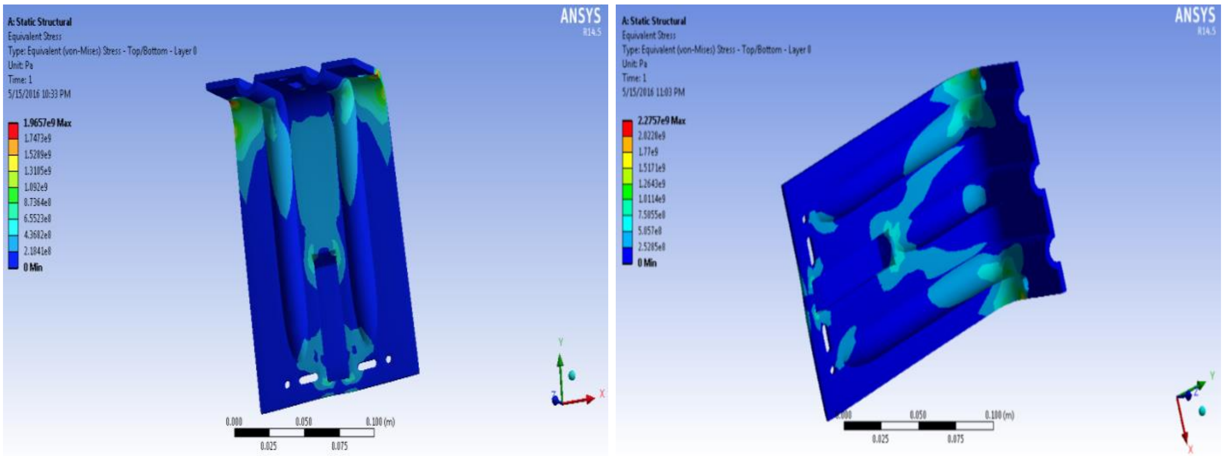
a b

Modelling of Stress before (a) and after (b) for 1 mm resisting bracket



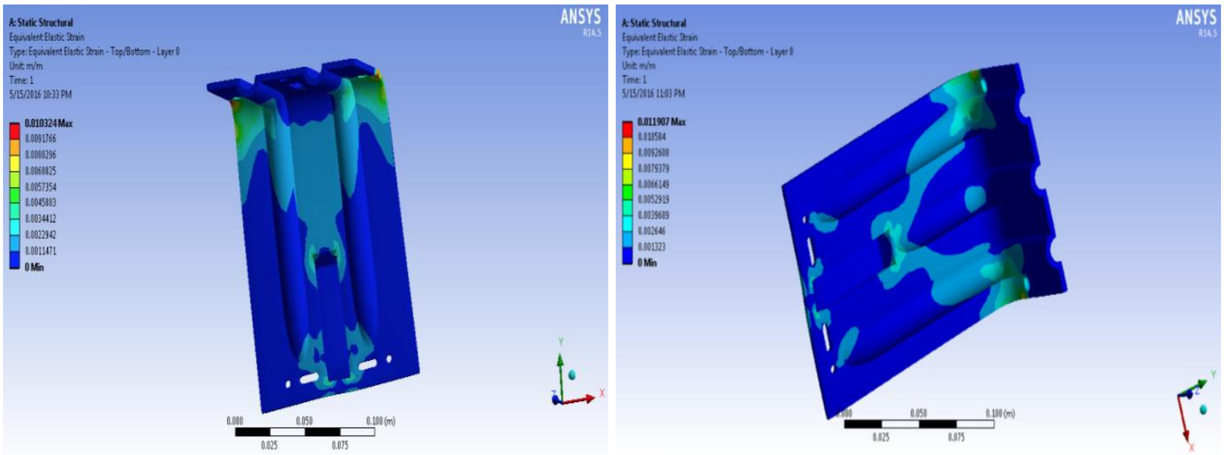
a b

Modelling of Strain before (a) and after (b) for 1 mm resisting bracket



a b

Modelling of Stress before (a) and after (b) for 3 mm resisting bracket



a b

Modelling of Strain before (a) and after (b) for 3 mm resisting bracket