OPTIMIZATION AND ANALYSIS (FAILURE MODE EFFECT AND FINITE ELEMENT) OF A COMMON DTH DISH ANTENNA BRACKET ASSEMBLY

Article · October 2014

9 authors, including:

Mohammed Yunus
Umm Al-Qura University,saudi arabia, mecca.

Hamza A. Ghulman
Umm Al-Qura University

Shadi Munshi
Umm Al-Qura University

Sufyan Azam
Umm Al-Qura University

INTERNATIONAL JOURNAL OF MECHANICAL ENGINEERING AND TECHNOLOGY (IJMET)

ISSN 0976 – 6340 (Print)
ISSN 0976 – 6359 (Online)
Volume 5, Issue 10, October (2014), pp. 28-44
© IAEME: www.iaeme.com/IJMET.asp
Journal Impact Factor (2014): 7.5377 (Calculated by GISI)
www.jifactor.com

IJMET

©IAEME

OPTIMIZATION AND ANALYSIS (FAILURE MODE EFFECT AND FINITE ELEMENT) OF A COMMON DTH DISH ANTENNA BRACKET ASSEMBLY

Dr. Mohammed Yunus[1], **Dr. Hamza A.Ghulman**[2], **Dr. Shadi M. Munshi**[3], **Sufyan Azam**[4], **Dr. J. Fazlur Rahman**[5], **Mohammed Irfan**[6], **Mohammed Asadulla**[7]

[1, 2, 3, 4](Department of Mechanical Engineering, College of Engineering and Islamic Architecture, Ummul Qura University, Mecca, Kingdom of Saudi Arabia)
[5, 6, 7](Department of Mechanical Engineering, H.K.B.K. C.E., Bangalore, Karnataka State, India-45)

ABSTRACT

Television (TV) is the most widely used telecommunication medium for transmitting and receiving moving images usually accompanied by sound. These signals are transmitted through either cable TV or DTH (Direct-To-Home), DTH is superior to cable TV since it offers better quality picture and it can also reach remote areas where terrestrial transmission and cable TV have failed to penetrate.

Bracket is an important part in the DTH assembly, which has to bear the antenna and feed horn (LNB converter) load and also wind force which acts on the antenna surface. It plays an important role in the reception of signal since the amount of signal receiving depends on the alignment angle of antenna, which causes the interruption in reception of signal, this is usually caused by a failure of bracket assembly used to mount the dish antenna. So it needs have good enough strength bracket.

The aim of the present work is to study the failure of the bracket and FMEA (failure mode effect and analysis) of plastic component. Optimization is carried out at the failure point location to overcome the existing chronic field failure. Different design concepts were developed and the best feasible concept is selected. The stresses were analyzed on the bracket using FEA software packages.

Keywords: Direct to Home (DTH), Dish Telivision, Die Designing Methodology, FMEA (Failure Mode Effect And Analysis), Finite Element Method, Analysis and Optimization.

1. INTRODUCTION

Television (TV) is the most widely used telecommunication medium for transmitting and receiving moving images usually accompanied by sound. The signals are reached to the television through either cable TV or DTH (Direct-to-Home). Cable television, also referred to as cable TV or CATV (Community Antenna Television), is a system wherein radio frequency signals are transmitted to television sets by means of fixed coaxial cables or fiber optic cables and have become so popular that more than half of the households in the world avail this service as of today. Whereas DTH stands for Direct-To-Home television, which is defined as the reception of satellite programmes with a personal dish in an individual home. DTH does away with the need for the local cable operator and puts the broadcaster directly in touch with the consumer. Only cable operators can receive satellite programmes and they then distribute them to individual homes.

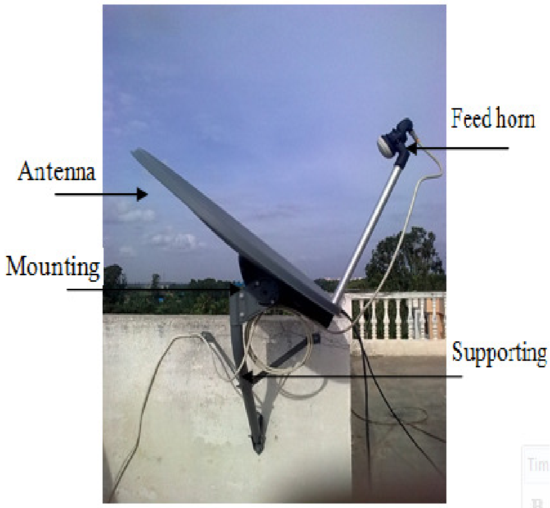


Fig 1.1 DTH dish antenna assembly

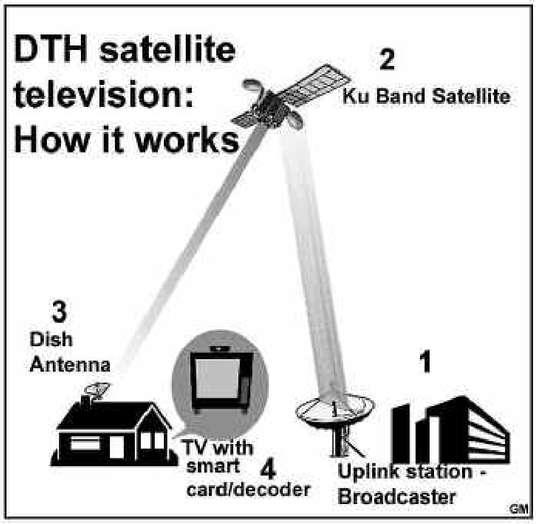


Fig 1.2 Conceptual diagram of a satellite communication

A DTH network consists of a broadcasting centre, satellites, encoders, multiplexers, modulators and DTH receivers. A DTH service provider has to lease Ku-band transponders from the satellite. The encoder converts the audio, video and data signals into the digital format and the multiplexer mixes these signals. At the user end, there will be a small dish antenna and set-top boxes to decode and view numerous channels. DTH is an encrypted transmission that travels to the consumer directly through a satellite. DTH transmission is received directly by the consumer at his end through the small dish antenna. A set-top box, unlike the regular cable connection, decodes the encrypted transmission.

1.1 Antenna mountings

Bracket is an important part in the DTH assembly, which has to bear the antenna and feed horn (LNB converter) load and also wind force which acts on the antenna surface. It plays an important role in the reception of signal since the amount of signal receiving depends on the alignment angle of antenna, which causes the interruption in reception of signal, this is usually caused by a failure of bracket assembly used to mount the dish antenna.Fig.1.3 shows Potential mounting sites or location of antennae and fig1.4 shows the TV Antenna wall brackets or Wall mounting brackets are ideal for ground-up and wall supported mast installations. The wall brackets are made of 16 gauge steel with a tubular support leg for additional rigidity. Which are also called Non roof penetrating TV antenna mounts.

1.2 Problems encountered by the customers while using DTH service

1. Frequent disruption of the service in case of heavy rainfall.
2. During rains, most of the times the digital TV ceases to work and there is no reception of signal.

3. Variation in the alignment of the antenna mounting bracket due to environmental condition.
4. Problem in the setup box and signal receiver.
5. The intensity of incoming signals reduces during high wind blowing over the antenna surface.
6. Even though the customer recharged, the TV channels are not getting in some DTH services.

A new dish design uses two or more horns to pick up different satellite signals. As the beams from different satellites hit the curved dish, they reflect at different angles so that one beam hits one of the horns and another beam hits a different horn. The central element in the feed horn is the low noise block down converter, or LNB. The LNB amplifies the signal bouncing off the dish and filters out the noise (signals not carrying programming). The LNB passes the amplified, filtered signal to the satellite receiver inside the viewer's house.

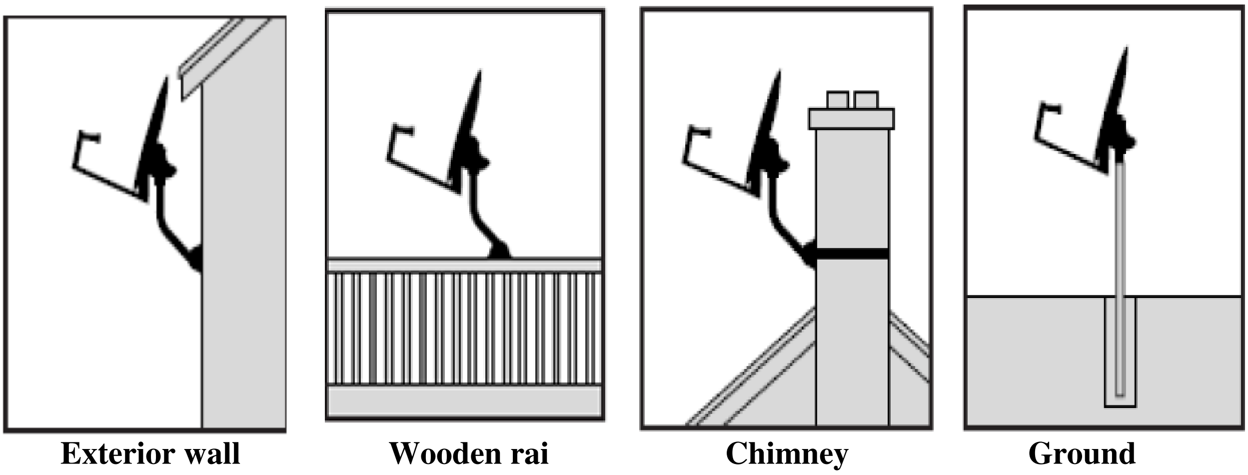


Fig 1.3 Different antenna mounting locations

Fig 1.4 TV Antenna wall brackets

2. LITERATURE REVIEW

2.1. Literature Review on Design Concept selection methods: The different design concept selection methods given by different authors are explained and also described the different benchmarking techniques such as Abdus salam[1] presented the mountings and their requirements to avoid any obstructions in reception of electromagnetic signals using non-penetrating roof mount antenna assemblies. Rolinski et al. [2] suggested the advantages of using an X-Y antenna mount for performing data acquisition and satellite tracking functions using servo-control system. Eric Michael Olsen et al. [3] invented an apparatus for holding an antenna on a mounting surface by use of suction cups or suction devices to restore or relocate to another mounting surface. Chang-Ho Cho et al. [4]

designed an antenna control system (discrete time controller) which capable of quickly and accurately tracking the target communication satellite and receiving of the signal transmitted from it without using any additional sensors. Comazell Bickham [5] invented portable adjustable stand for satellite dish antennas for mounting and supporting a digital satellite dish antenna eliminates the need for drilling holes and physical attachment to the surfaces of a dwelling with screws, bolts, or other fasteners. Albert Hugo [6] describe a motor driven adjustable mounting structure for satellite television dish antenna which operates to scan an in line of sight segment of a geostationary TV relay satellite orbit belt.

2.2. Literature Review on FMEA and Benchmarking: FMEA is used to identify potential failure modes, determine their effect on the operation of the product, and identify actions to mitigate the failures. Irem Y. Tumer et al. [7] have developed an approach for failure mode identification for the product development. a statistical clustering procedure is proposed to retrieve information on the set of predominant failures that a function experiences. Seung J. Rhee et al. [8] developed a new methodology, Life Cost-Based FMEA, which measures risk in terms of cost which is useful for comparing and selecting design alternatives. Derham et al. [9] explained failure mode analysis for plastic components used in engineering applications. Sellappan Narayanagounder et al. [10] showed the drawbacks in traditional FMEA and demonstrated a new approach to prioritize failure modes by evaluation of risk priority number. If two or more failure modes have the same RPN, suggested to prioritize the failure modes with the help of Risk Priority Code (RPC). Mohammad Reza Mehregan et al. [11] developed a simple quantitative methodology for benchmarking process, where analyze phase is developed based on two popular mathematical programming techniques TOPSIS and goal programming. Busby et al. [12] investigated the practices that engineering designers had learned to apply during concept selection. Hambali et al. [13] proposed a concept selection model called concurrent design concept selection and materials selection (CDCSMS) for appropriate design and materials at the conceptual design stage using analytical hierarchy process (AHP).

3. METHODOLOGY

Generally the mounting bracket in DTH assembly is designed to mount the antenna and the feed horn. As already discussed the bracket plays very important role for supporting the antenna and also in the reception of signal. The presently used bracket is manufacturing with the ABS material. The investigation was carried out with respect to existing DTH antenna mounting bracket. A number of design improvements have been carried out on existing model since it introduced. The improved with new design concept version is designated as New model. Since it was realized that there are some areas where performance specification of new model can be improved.
In the existing design there are some disadvantages they are:

1. The material thickness is less in some areas (those are called critical regions).
2. The failure is occurring in the critical regions due to the developed stress.

Based on the disadvantages in the existing design the problem is taken up with different design concepts. The aim of the present work is to study the failure of the antenna mounting bracket. Optimization is carried out at the failure point location to overcome the existing chronic field failure. Different design concepts were developed and the best feasible concept is selected for design and analysis. The model has developed using the CATIA modeling software. The stresses and displacements were analyzed on the bracket using Hyper mesh preprocessor and NASTRAN solver packages.

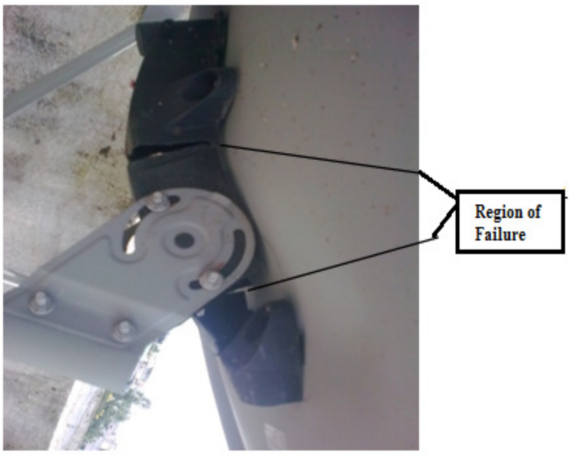


Fig 3.1 Existing mounting bracket failure zone

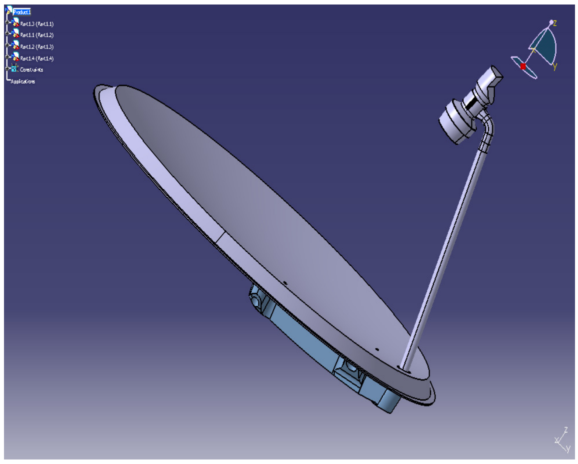


Fig 3.2: Assembled view of DTH using CATIA

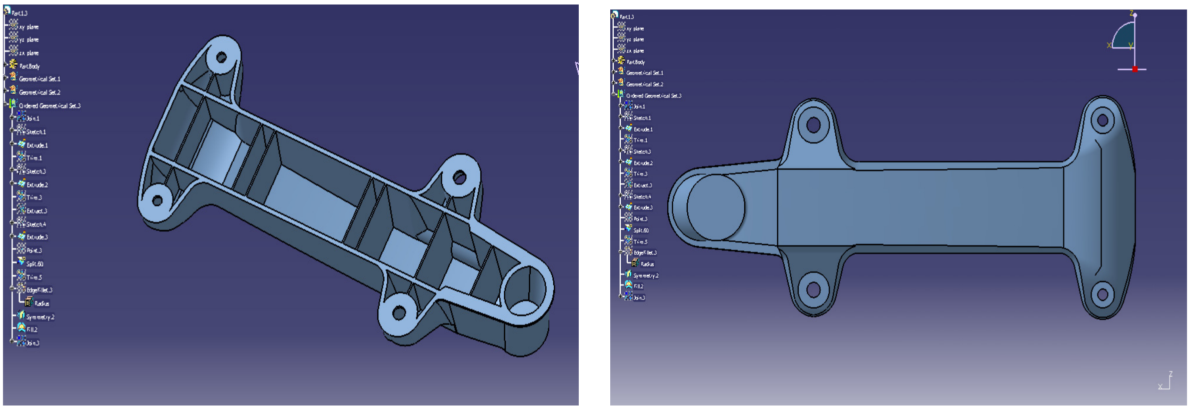


Fig. 3.3: Isometric view and Rear view Geometric model of the mounting bracket

When choosing the right antenna mount, these three factors to keep in mind: Size, Type and Cost. Figure 3.2 shows the assembly of the different parts of the DTH system and Fig.3.3 shows the different dimensions of the mounting bracket in the two different views.

3.1 Component modeling

Modeling of the component was done using commercially available software CATIAV5. It provides the tools to accurately model and document the design ready for rendering, animation, mechanism drafting, engineering, analysis and manufacturing or construction.

The selection of the appropriate antenna size helps in keeping the network up and healthy. It is decided based on the following:

1. Satellite Effective Isotropic Radiated Power (EIRP) at the particular location.
2. Rain attenuation at the location.

Adequate E_b/N_o (the energy per bit to noise power spectral density ratio) for reception of excellent picture quality.

3.2. FMEA (Failure Mode and Effect Analysis) and Benchmarking

Failure Mode and Effects Analysis (FMEA) is commonly defined as “a systematic process for identifying potential design and process failures before they occur, with the intent to eliminate them or minimize the risk associated with them”. The FMEA technique was first reported in the

1920s but its use has only been significantly documented since the early 1960s. It was developed in the USA in the 1960s by National Aeronautics Space Agency (NASA) as a means of addressing a way to improve the reliability of military equipment. FMEA is used to identify potential failure modes, determine their effect on the operation of the product, and identify actions to mitigate the failures. A crucial step is anticipating what might go wrong with a product. Various benefits of FMEA

- Improve product/process reliability and quality and increases customer satisfaction.
- Early identification and elimination of potential product/process failure modes.
- Prioritize product/process deficiencies to Provide focus for improved testing and development.
- Capture engineering/organization knowledge and Minimizes late changes and associated cost.
- Documents risk and actions taken to reduce risk.
- Catalyst for teamwork and idea exchange between functions.

3.2.1. Types of FMEA's

There are several types of FMEAs, some are used much more often than others. FMEAs should always be done whenever failures would mean potential harm or injury to the user of the end item being designed. The types of FMEA are:

- System - focuses on global system functions
- Design - focuses on components and subsystems
- Process - focuses on manufacturing and assembly processes
- Service - focuses on service functions
- Software - focuses on software functions

3.2.2. FMEA Methodology

The flow chart given below describes the procedure involved in the FMEA. The basic step is to identify the potential failure mode and its effect on the system. It also shows the parameters used to determine the criticality of an item failure mode are, the severity of its failure effects, its frequency of occurrence, and the likelihood that subsequent testing of the design will detect that the potential failure mode actually occurs.

Severity is a rating corresponding to the seriousness of an effect of a potential failure mode on the next higher level assembly, the system or the user. (Scale: 1-10. 1: no effect on output, 5: moderate effect, 8: serious effect, 10: hazardous effect)

Occurrence is a rating corresponding to the rate at which a first level cause and its resultant failure mode will occur over the design life of the system, over the design life of the product, or before any additional process controls are applied. (Scale: 1-10. 1: failure unlikely, 5: occasional failure, 8: high number of failures likely, 10: failures certain).

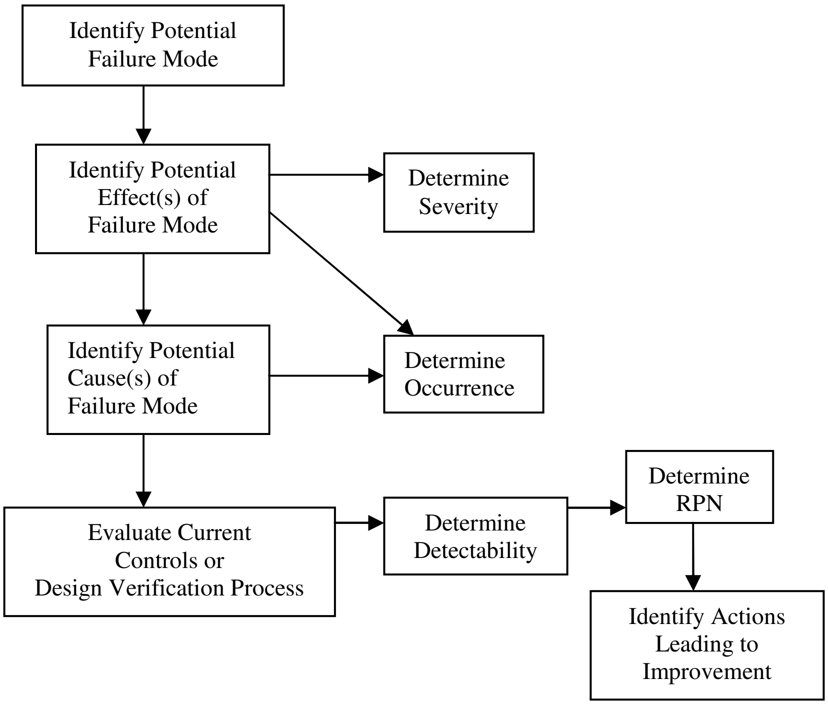


Fig 3.4: Flow chart of FMEA methodology

Detection is a rating corresponding to the likelihood that the detection methods or current controls will detect the potential failure mode before the product is released for production for design, or for process before it leaves the production facility. (Scale: 1-10. 1: will detect failure, 5: might detect failure, 10: almost certain not to detect failures)

Risk Priority Number (RPN)

The RPN is a mathematical product of the severity(S), the occurrence (O) and the detection (D). It is used to identify the most critical failure mode, leading to corrective action

In equation form, **RPN = S x O x D**

Reasons for observed failure

- In effective loading due to weather conditions that is too much wind.
- Unexpected load may occur due to negligence in the form of access to domestic animals.
- Stress localization observed at the critical points.
- Manufacturing defects may appear in the mounting bracket.

3.2.3 FMEA Worksheet

Table 3.1: FMEA work sheet for DTH mounting structure

Process operation, product function or purpose	Potential failure mode	Potential effect(s) of failure	SEV	Potential cause(s) of failure	OCC	DET	RPN	Recommended Action(s)
Mounting bracket Support the antenna and LNB	Crack initiation Breakage	DTH assembly fail to work	7	Excess load Manufacturing defect	6	4	168	Modify the design of bracket
	Alignment angle of antenna	Problem in reception of signal	6	DTH assembly not fitted properly	7	3	126	Fixing DTH at appropriate place. Assemble components properly

3.2.4 Different types of mounting bracket

Type 1

Type 2

Type 3

Type 4

Fig 3.5: Different types of DTH antenna mountings

The scaling given in the above table for the benchmarking of the different types of DTH antenna mountings available in the market is as follows;

(i) Bear to more weight corresponds to the ability of the bracket which can be able to withstand for the load (Scale: 1-10. 1-less weight, 5-average weight, 10-more weight).

(ii) Serviceable life related to the working life of the bracket without failure. (Scale: 1-10. 1-failure occurs very early, 5-average life, 10-failure doesn’t occur).

Table 3.2: Benchmarking table of antenna mountings

Types Parameters	Type 1	Type 2	Type 3	Type 4
Bear to more weight	7	6	6	7
Serviceable life	8	6	6	7
Cost	5	7	7	4
Boundary(surface) contact	4	7	7	6
Geometry complexity	8	5	4	7
Total	32	31	30	31

(iii) The cost of bracket corresponds to the market price of the bracket. (Scale: 1-10. 1-very high cost, 5-high cost, 7- considerable cost, 10-less cost).

(iv) Boundary contact related to the area of contact or surface contact between the antenna and the bracket. It also relates to the amount of load transfer to the bracket, that is if the contact is good then the load will transfer equally to all portion of the mounting bracket and chances of failure is less compare to the poor contact. (Scale: 1-10. 1-less contact, 5-average contact, 10-full contact).

(v) Geometry complexity corresponds to how easily the bracket can be manufactured. (Scale: 1-10. 1- very difficult to manufacture. 5-with considerable effort, 10- can easily manufacture).

3.3. Concept Design and Generation

3.3.1. Design requirements

To provide good enough strength to the bracket, the following parameters should be taken in to account in the design:

Ribbing pattern: Ribs are commonly used to give strength and rigidity to the product. At the same time, ribs help to have thinner walls and therefore reduce the amount of material. The structure of bracket can be strengthened by ribs in specific places in order to form a more rigid and stabilized structure. The ribs are strengthening plates mainly placed along the vertical direction for preventing deflection of lateral surfaces and thus creating a rigid structure and reduce deflection.

Thickness: By increasing the material thickness of bracket at critical points, it will greatly improve the bracket strength. The strength to weight ratio is improved by adding to material thickness. It is well known that when the thickness of a product is increased, the weight of a product increases proportionally. Thus, it is important to determine the right thickness of bracket.

Curvature structure: Curvature structure of bracket determines the level of contact with the antenna surface. Since the antenna surface is curved, the effect of load transfer to the bracket depends on the contact between antenna and bracket.

Material selection: Bracket design is greatly influenced by the material selected. There are 2 factors that must be considered by designers in determining the best design concept at the early stage of product development process, namely, (a) formability of materials and (b) recyclability of materials.

Cost consideration: It is about 70% of the cost of a product that is determined before production activity. Therefore, it is very important to design and develop mounting bracket which contributes to the cost reduction without sacrificing its safety and impact performance characteristics. The two most important costs required to be considered in designing the bracket, namely, (a) Material cost (b) Manufacturing cost

Manufacturing process: Manufacturing process is also needed to be considered when designing antenna mountings at the early stage of the product development process with ease to fabricate.

Maintenance: There are two main factors influencing the selection of the antenna mountings related to maintenance consideration, namely, Easy to dismantle and Easy to install

3.3.2. Force Calculation

The static force develops in the DTH assembly due to the weight of the antenna and the feed horn (LNB) is given by

F (force) **= M (mass) x a(acceleratio**n due to gravity, $9.81 m/s^2$)

1. Force due to feed horn mass acts at the lower portion of the bracket, where the feed horn is placed and is given by

$F = 200x10^{-3}$ x 9.81 where Mass of the feed horn is $200x10^{-3}$ kg

F = 1.962 N

2. Force due to dish antenna mass

$F = 1400x10^{-3}$ x 9.81 where mass of the dish antenna is $1400x10^{-3}$ kg

F = 13.734 N

3. The force developed due to the wind pressure is calculated as follows

The force equation is given by

$$F = A \times P \times C_d$$

Where, P = wind pressure of 0.04, Cd = drag co-efficient of 1, V = wind speed of 80 kmph

A = the projected area of the item is given by

A = π a b a= major dia= 0.62m, b= major dia= 0.55m

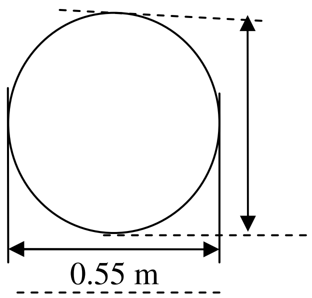
$A = 1.0713 m^2$

Force F = 513.19 N

The total force acting on the antenna mounting bracket

= force due to antenna mass + wind force

= 13.734 + 513.19 = 530 N



This force acts on the mounting bracket where the contact between antenna surface and bracket takes place. Usually it is considered as uniformly distributed load and acting at an inclination since the bracket mounted at an angle with respect to horizontal surface.

3.3.3. Material Properties

Plastic material is used to manufacture most of the antenna mounting bracket since plastics have more advantages compared to the metals. Acrylonitrile-Butadiene-Styrene (ABS) material is used to manufacture the antenna mounting bracket. It has excellent impact resistance, aesthetic qualities, good strength, rigidity**,** abrasion resistance, dimensional stability, resistance to low temperatures, creep resistance and stiffness and low cost. And it ha many applications in making Machined prototypes, Structural components, Support blocks, Housings and covers, Telephone handset, domestic appliances (food processors, fans, TV sets), Food containers, radiator grills.

3.3.4. Concept Generation for Optimization

Design concepts selection (DCS) is an area of design research that has been under considerable interest over the years (Salonen and Perttula, 2005). It is one of the important activities for a product development process and decision making phase of concept design, where designers evaluate concepts with respect to customer needs. According to Gerrit Muller Selection techniques should be used in the early phases of product development when stakeholder are known and when requirements are established.

Here we developed mainly three concepts and the FEA model is developed by using basic model as reference for all three concepts and analysis was done. Based on the obtained von-misses stress results, the good concept selected.

Concept 1 Providing ribs

This concept is developed based on the literature that the ribs provide strength and rigidity to the product. In present model only horizontal ribs are present so we planned to provide vertical ribs. The two ribs are placed along vertical direction at equal distance from the center plane of the bracket.

Concept 2 Thickness increased

Actually at the failure point the material thickness is less as compared to the other part of the bracket, so from the literature the strength will increase as the thickness increased. Based on this we developed the above concept where material thickness is increased to some extent.

Concept 3 Ribs with thickness

In this concept the both features are included that is the thickness is increased at failure point and also ribs are provided in vertical direction.

Concept 4 Change of material

In this concept, material used for manufacturing the mounting bracket is changed. Instead of ABS material we used polypropylene thermo plastic material, since compare to the other material it has high strength and also low density.

The material properties are given by

Table 3.3: Polypropylene material properties

Property	Value in metric unit	
Density	**0.91×10^3**	**kg/m^3**
Modulus of elasticity	**1.36**	**GPa**
Strength	**37**	**MPa**
Poisson's ratio	**0.3**	**-**
Flexural strength	**49**	**MPa**
Thermal expansion (20 °C)	**90×10^{-6}**	**$^oC^{-1}$**
Maximum work temperature	**150**	**°C**

3.4. Finite Element Analysis of Mounting Bracket for optimization of concepts

In this initially the finite element model is generated and analysis is done for the basic model of bracket and taking basic FEA model as reference, the FEA models for the different concepts are developed and analysis done for each different concepts.

3.4.1 Basic model

Figure 3.6, 3.7, 3.9, 3.11, 3.13 shows the FEA model of the original bracket, concept-1, concept-2, concept-3 and concept-4 having QUAD4, TRIA3 elements and these elements are satisfied the all quality parameters and with the boundary conditions applied and the applied forces and the constraints at different points. The different color elements represent the different collectors having variation in thickness. Figure 3.8 shows von-misses stress distribution of the basic model, here we observed that the stress generated more at the section having thin cross sections, where the actual failure had taken place.

3.4.2 Model with ribs provided

The FEA model and Von-misses stress distribution for the concept-1 are shown in Fig. 3.9 and 3.10 respectively. Analysis result shows that stress developed in the bracket is slightly reduce compare to failure stress.

3.4.3 Model with thickness increased

The FEA model and Von-misses stress distribution for the concept-2 are shown in Fig. 3.11 and 3.12 respectively. Analysis result shows that stress developed in the bracket is reduced more compare to concept1.

3.4.4. Model with ribs and increased thickness

The FEA model and Von-misses stress distribution for the concept-3 are shown in Figures 3.13 and 3.14 respectively. Analysis result shows that stress developed in the bracket is reduce to considerable amount of failure stress.

3.4.5 Model with material change

The FEA model for this concept is same as the basic model but only material properties are changed. Von-misses stress distribution for the concept-4 is shown in Fig. 3.15. Analysis result shows that stress developed in the bracket is reducing slightly compare to failure stress.

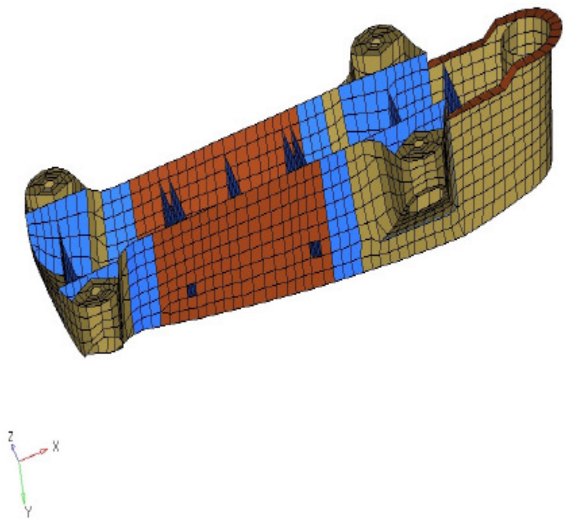


Fig 3.6: FEA model of the original bracket

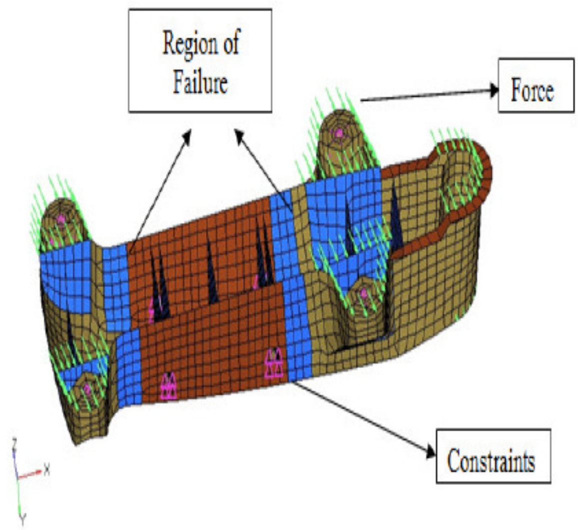


Fig 3.7: Basic FEA model with boundary conditions

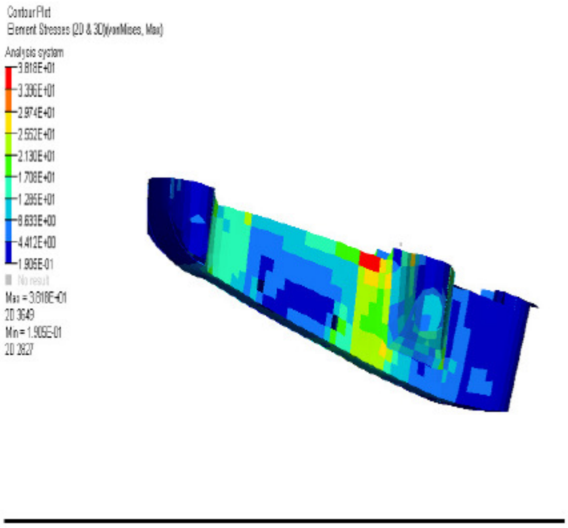


Fig 3.8: Von-misses stress distribution of basic model

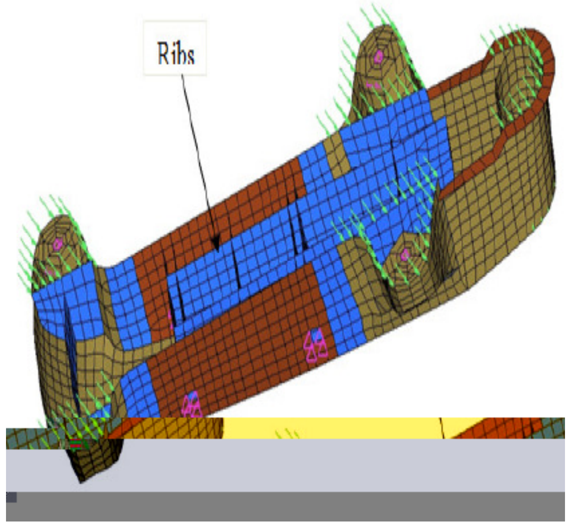


Fig 3.9: Concept-1 model with boundary conditions

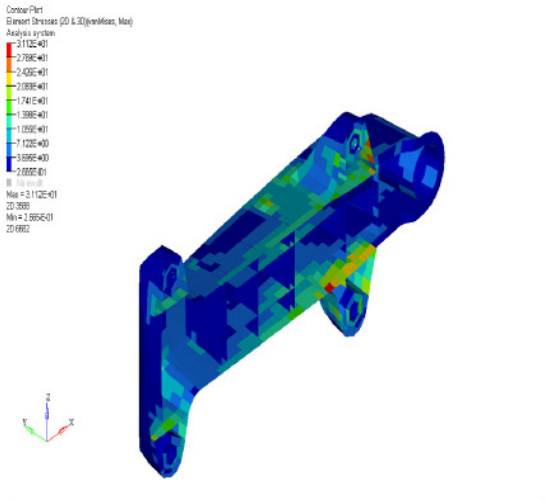


Fig.3.10: Von-misses stress distribution of concept-1

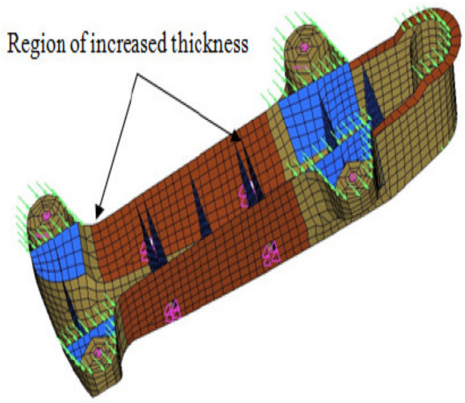


Fig.3.11: Concept-2 model with boundary conditions

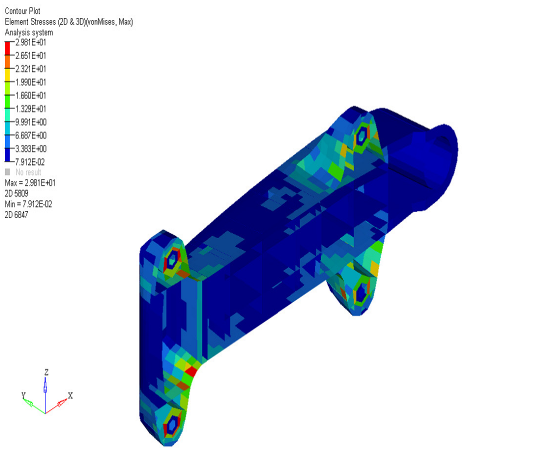


Fig.3.12: Von-misses stress distribution of concept-2

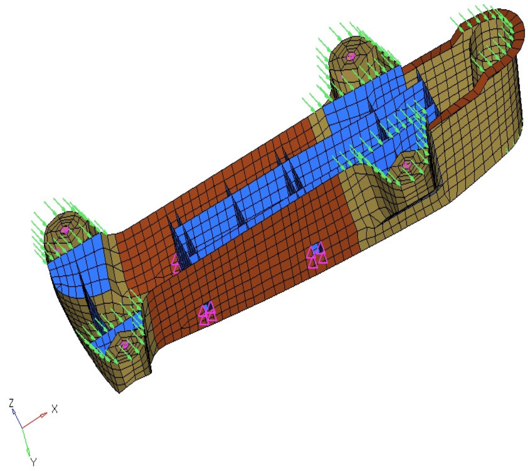


Fig. 3.13: Concept-3 model with boundary conditions

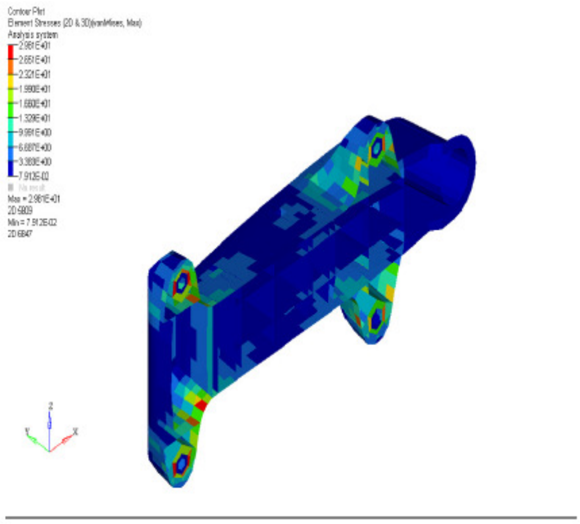


Fig.3.14: Von-misses stress distribution of concept-3

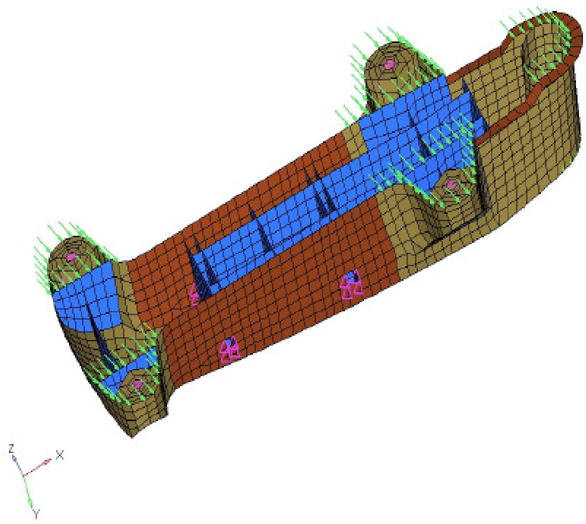


Fig.3.15: Von-misses stress distribution of concept-4

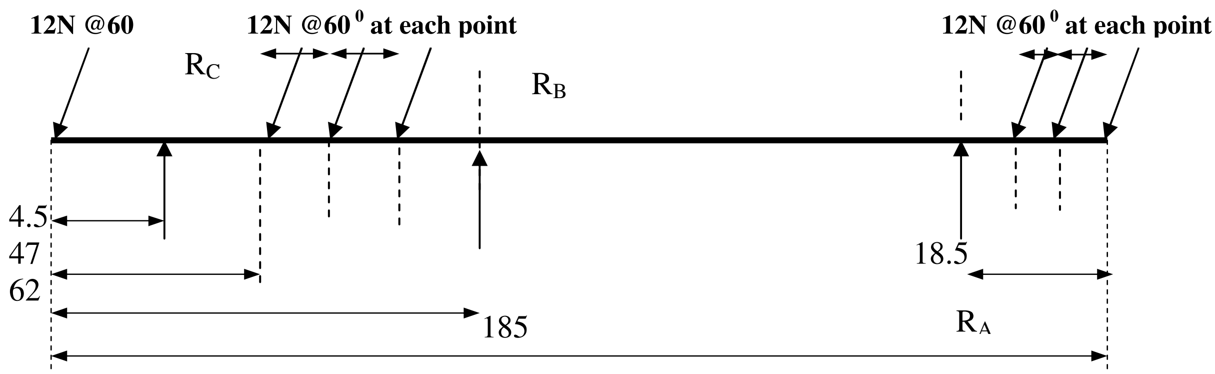
3.5. Validation of the Analysis

In this section the software and the element type used for the analysis is validated with the theoretical results for the stress developed in the bracket. The geometry of the bracket is symmetric therefore considered only half portion. Assuming it as simply supported beam. The different forces acting at different point are shown in figure below; all dimensions are in “mm”.

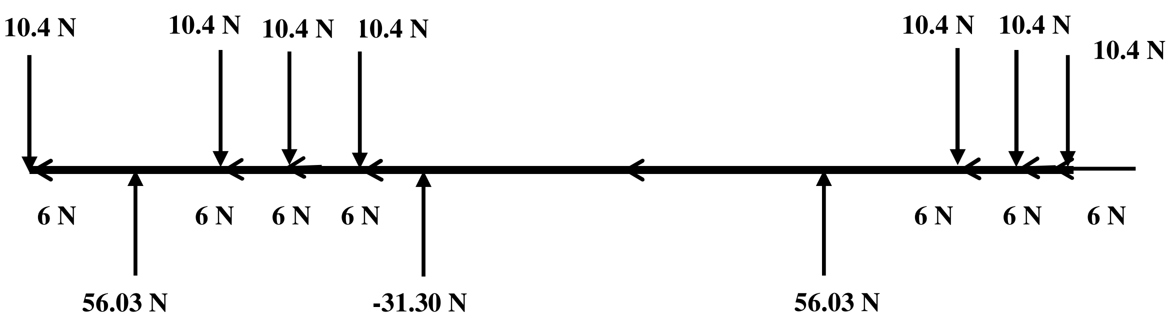
To obtain stresses in bracket

To obtain the combined stresses acting on the selected portion of the bracket, it is sliced in to three different sections which are as shown in the Fig 7.12 and Following are the steps followed to calculate the combined stresses acting at each section

- Evaluating the sectional area (A) and distance of centroid
- Calculating moment of inertia at centroidal axis (I)
- Obtaining bending (σ_b), direct (σ_d) and combined stresses (σ_c)



After resolving



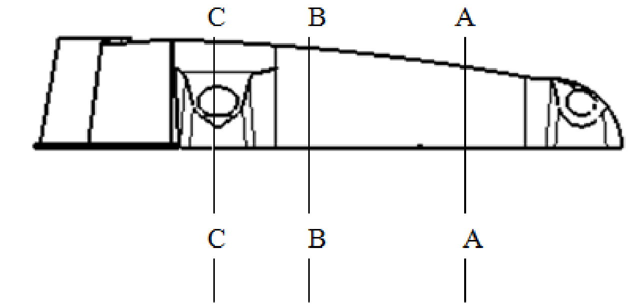


Fig 3.16: Different sections of bracket structure

At section A-A

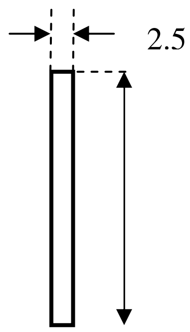


Fig. 3.17: Section A-A of Bracket

L=18.5mm from Tail (right end) point
b=2.5mm; h=10 mm;

$$sectional\ area = b \times h = 2.5\times10 = 25\ mm^2$$

$$I = b\times\frac{h^3}{12} = 2.5\times\frac{10^3}{12} = 208.33\ mm^4$$

Bending stress

$$\left.\begin{matrix}Bending\\ Stress\end{matrix}\right\}\sigma_b = \frac{M\times c}{I} \quad C=10/2=5.0\ mm \qquad \sigma_b = \frac{-436.8\times5}{208.33} = -10.4832\ N/mm^2$$

$$\left.\begin{matrix}Direct\\ Stress\end{matrix}\right\}\sigma_d = \frac{Reaction\ force\ at\ A-A}{Sectional\ area} = \frac{-18}{25} = -0.729\ N/mm^2$$

$$\left.\begin{matrix}Combined\\ Stress\end{matrix}\right\}\sigma = \sigma_b + \sigma_d = -10.4832 - 0.729 = -11.203\ N/mm^2$$

Similarly A, $\overline{Y}$ I, σ_b, σ_d and σ_c for remaining sections are tabulated below.

Table 3.4: Combined stress values at different sections in bracket

Section	A mm^2	$\overline{Y}$ mm	I mm^4	σ_b N/mm^2	σ_d N/mm^2	σ_c N/mm^2
A-A	25	5.0	208.33	-10.4832	-0.729	-11.203
B-B	50	10.0	1666.67	-7.95	-0.48	-8.43
C-C	56.5	14	188.75	-16.4	-0.68	-17.08

Table 3.5: Comparison of theoretical analysis results

Sections	Theoretical (MPa)	Analysis (MPa)
A-A	-11.203	16.60
B-B	-8.43	13.29
C-C	-17.08	19.92

4. RESULTS AND DISCUSSION

In this chapter the analysis results of different concepts are interpreted and showed the variations of von-misses stress developed in the different concepts. In the above plot: 0,1,2,3,4 = represent the basic model, concept-1, concept-2, concept-3 and concept-4 respectively.

The percentage of reduction in the stress generated for different concepts are given in table. From the analysis plot we can observe that in the concept-3, the stress reduction is more compare to the other concepts, but we selected the concept-2 is best concept since Simple design and more feasible, Economical in the manufacturing point of view. The existing dies with slight modification, can be used for manufacturing the bracket.

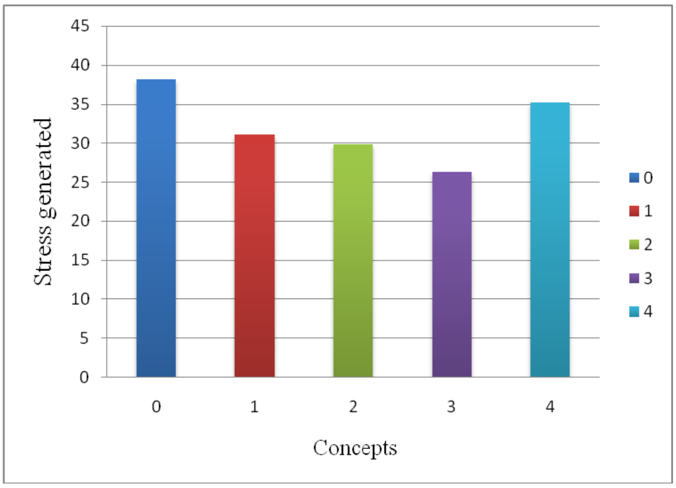


Fig 4.1: Stress generated v/s Concepts

Table 4.1: Stress reduction in different concepts

Concepts	% reduction
Concept1	18.50
Concept2	21.92
Concept3	31.04
Concept4	7.67

5. CONCLUSION

The present work is to improve the strength of the bracket, for this FMEA, Benchmarking and analysis have done by considering all the parameters. FMEA result shown that the risk priority number (RPN) has more for the failure of mounting bracket compare to the other possible problems. Hence modification has done in the geometry of the bracket.

Benchmarking has done to know the different types of bracket available in the market which are more feasible. It shows that type-1, type-2 and type-3 are almost having same rank but due to some disadvantages of type-1 the other two are now-a-days majorly used by the customers. As already stated the design concept-2 is the best possible concept for manufacturing the bracket. Hence finally it is concluded that new design is better than existing design. Further study is required to develop the prototype model and conducting the test experimentally and compare the analysis and experimental results. Some parameters could be included in future analysis like examining the model under non linear condition and composite material may be used to manufacture the bracket.

REFERENCES

[1] Abdus Salam ICTP, "Site Surveying and Antenna Mounting", 2007.
[2] A. J. Rolinski D. J. Carlson and R. J. Coates, "The X-Y Antenna Mount for Data Acquisition from Satellites". 1962, pp-159-163.
[3] Eric Michael Olsen and Wiley Clifton Darling, "Antenna mount with alternative", 2007.
[4] Chang-Ho Cho, Song-Hyo Lee, Tae-yong kwon and Cheollee, "Antenna control system using step tracking algorithm with H controller". Vol.1, No.1, 2003, pp 83-92.
[5] Allan L. Turner and Davis Tehachapi, "Satellite TV dish antenna support", 1987.
[6] Albert Hugo, "Television dish antenna mounting structure", 1986.
[7] I.Y. Tumer, Srikesh G. Arunajadai and R.B.Stone, "Failure mode identification through clustering analysis", 2001, Pittsburgh.
[8] Seung J. Rhee and Kosuke Ishii, "Using cost based FMEA to enhance reliability and serviceability", Vol. 17, 2003, pp 179-188.
[9] C.J. Derham and J. Mater, "Failure mode analysis of plastics components & parts", 2008.
[10] Sellappan Narayanagounder and Karuppusami Gurusami, "A new approach for prioritization of failure modes in design FMEA using ANOVA", 2009, pp 524-531.
[11] Mohammad Reza Mehregan , Mahmoud Dehghan Nayeri and Vahid Reza Ghezavati, "An optimisational model of benchmarking", Vol. 17, No. 6, 2010, pp 876-888.
[12] J. S. Busby, "Practices in Design Concept Selection as Distributed Cognition", Vol 3, 2001, pp 140-149.
[13] A. Hambali, S. M. Sapuan1, N. Ismail and Y. Nukman, "Application of analytical hierarchy process in the design concept selection of automotive composite bumper beam during the conceptual design stage". Vol.4, 2009, pp 198-211.
[14] Dr. R. Dillibabu, Sangeetha. A and L. Sudha, "Development and Application of SFMEA Model to Software Testing Environment", International Journal of Mechanical Engineering & Technology (IJMET), Volume 4, Issue 3, 2013, pp. 61 - 72, ISSN Print: 0976 – 6340, ISSN Online: 0976 – 6359.
[15] Pravin Kumar.S, Venkatakrishnan.R and Vignesh Babu.S, "Process Failure Mode and Effect Analysis on End Milling Process- A Critical Study", International Journal of Mechanical Engineering & Technology (IJMET), Volume 4, Issue 5, 2013, pp. 191 - 199, ISSN Print: 0976 – 6340, ISSN Online: 0976 – 6359.
[16] A.Mariajayaprakash, Dr.T. SenthilVelan and K.P.Vivekananthan, "Optimisation of Shock Absorber Parameters using Failure Mode and Effect Analysis and Taguchi Method", International Journal of Mechanical Engineering & Technology (IJMET), Volume 3, Issue 2, 2012, pp. 328 - 345, ISSN Print: 0976 – 6340, ISSN Online: 0976 – 6359.