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Optimization of Green Composites for Automotive Applications Using a Hybrid Statistical and Computational Approach

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ABSTRACT

The development of material is leading to utilize polymer instead of other material due to low cost of processing and recycling and easy to derivation, but now a day most of research led attention for using polymers due to contaminating the environment because of green composite material manufactured by natural fiber in this project banana and jute combined to create hybrid fiber.

Bamboo fiber reinforced with polyester matrix to improve mechanical properties, Delamination is common issue that focused by many researcher while preferring drilling as machining operation, result indicate that critical parameter were(Cutting speed, feed rate, diameter of cutting tool), delamination can be decreased by distinguishing a proper cutting condition, study of this research is showing that optimization of Maximum load carrying by Fuzzy and Topsis method, the input of this two method is(CNSL matrix, fiber length, Volume fraction) to optimizing(Thrust force, torque, Surface roughness, material removal rate, s plus, s minuses, closeness coefficient, S/N Ratio) then determining ideal best and ideal worst of them to optimize maximum load carrying capacity, the characteristic of composite material will be distinguished by how to behave while machining.

Acknowledgement

Firstly, we would like to express our special thanks of gratitude to our supervisor as well as our principal Dr.-Ing. Rastee D. Ali, who gave us the golden opportunity to do this wonderful project on the topic. He also helped us in doing a lot of research and we came to know about so many new things. We are really thankful to them.

Secondly we would also like to thank our parents and friends who helped us a lot in finalizing this project within the limited time frame.

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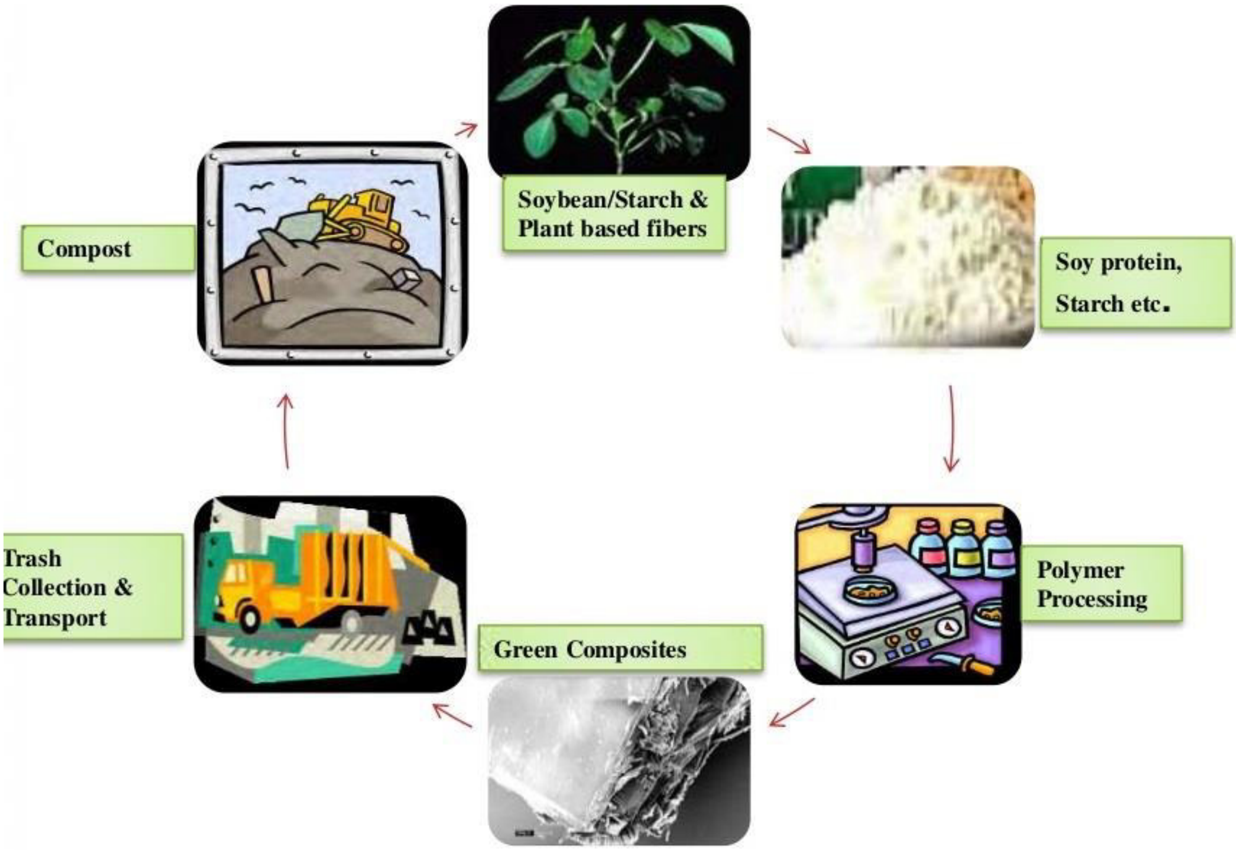
CHAPTER ONE
GREEN COMPOSITE

1.1 INTRODUCTION

Natural fibers have appeared to be the materials which will become a feasible replacement for non-renewable, abrasive and expensive synthetic fibers during recent years, mainly due to their availability in large quantities, biodegradability, low cost, low density, recyclability and ease of manufacturing them "Beghezan defines as ―The composites are compound materials which differ from alloys by the fact that the individual components retain their characteristics but are so incorporated into the composite as to take advantage only of their attributes and not of their short comings, in order to obtain improved materials"

A Biomaterial is a non-viable material used in medical device, so it's intended to interact with biological systems. Requirements of Biomaterials are It must be inert or specifically interactive. It must be Biocompatible. Mechanically and chemically stable. Biodegradable Process able (manufacturability) It must be machinable, and moldable. Sterilizable, non-toxic, non-allergenic, blood compatible, non-inflammatory. Physical Characteristics Requirements: Strength, Toughness, Elasticity, Corrosion-resistance, Wear resistance, Long term stability Natural fibers are a major renewable resource material throughout the world specifically in the tropics. According to the food and agricultural organization survey, natural fibers like jute, sisal, coir, banana, etc. are abundantly available in developing countries.

Natural fibers are an attractive research area because they are eco-friendly, inexpensive, Abundant and renewable, lightweight, low density, high toughness, high specific properties, biodegradability and non-abrasive to processing characteristics, Therefore, natural fibers can serve as reinforcements by improving the strength and stiffness and also by reducing the weight of the resulting bio composite materials although the properties of natural fibers vary with their source and treatments. A Bio-material is defined as any systemically, pharmacologically inert substance or combination of substances utilized for implantation within or incorporation with a living system to supplement or replace functions of living tissues or organs. [AFSR11]



Fig(1): The life cycle of natural fiber. [AFSR11]

Biomaterial devices used in orthopedics are commonly called implants; these are manufactured for a great number of orthopedic applications The use of natural fibers reduce the 10% of weight and lower energy used with production by 80% and while the cost of component 5% lower than the comparable fiber glass reinforced component. A key factor driving the increased applications of composites over the recent years is the development of new advanced forms of fiber reinforced materials. Fiber reinforced composites are lightweight, no-corrosive, exhibit good specific strength and good stiffness, are easily constructed, and can be tailored to satisfy performance requirements. Apart from these characteristics natural fibers are still expensive today as compare to traditional materials because of less demand of products manufactured from these fiber materials because of less knowledge of these fibers applications.

1.2 Application of green composite

- False ceilings
- Partition purposes
- Doors
- Furniture
- Boxes for agriculture purposes
- Rims
- Automotive
- Mobile panel
- Toys

1.3 Advantages of green composites over traditional composites

1. Less expensive.
2. Reduced weight.
3. Increased flexibility.
4. Renewable resource.
5. Sound insulation.
6. Thermal recycling is possible where glass poses problems.
7. Friendly processing and no skin irritation.

1.4 Disadvantages of green composites

1. Lower strength properties (especially impact strength).

2. Good moisture absorption causing swelling of fibers.
3. Lower durability.
4. Poor fire resistance and irregular fiber lengths are the disadvantages. However, recent fiber treatments have improved these properties.

CHAPTER TWO

LITERATURE SURVEY

2.1 Literature survey

A detailed comprehensive literature review on natural filler reinforced polymer composite material, and sugar cane bagasse fiber reinforced polymer composite material is presented including different type of polymer, filler dimensions ,applications, etc.

Jayaramudu, et. al. studied with natural Polyalthiacerasoide woven fabrics mixing with epoxy composite. The woven fabrics extracted from bark of the tree to make hybrid composites. The hand lay-up technique was used to fabrication of hybrid composite at room temperature. The surface modification of woven fiber was done by the process of alkali treatment. The microstructure and morphology studied was completed using Fourier transforms infrared spectroscopic (FTIR) and scanning electron microscopic methods respectively. The FTIR analyses represent the least value of hemi-cellulose and lignin contents of alkali treated woven fabric. The hybrid composite suggested for various applications in building and construction industries as panels for partitioning, flooring, storage tanks and table taps, etc. [JARSR15].

Chanda, et. al. were studied wood dust particle reinforced in epoxy based composite for analysis of mechanical behavior. The sundry wood dust particle used as reinforcement and LY 556 epoxy for resin. The six different percentage of filler particle used in study. Tensile and flexural test were carried out using UTM and sample size based on ASTM Standard. The different design parameters like as filler content and speed for loading with tensile and flexural strength using GRA were optimized . Optimization by GRA has the advantage of selecting best and worst options. GRG shows that test run number 13 is the best suited and test run number 3 is the least important. Epoxy composite with 10 filler contents (wt%) at corresponding speed of 1 mm/min shows best performance and on the other hand with 0 filler content (wt%) at the speed of 3 mm/min shows the worst performance. [CKKB14]

Motaung and Anandjiwala. studied of behavior of sugar cane bagasse particle reinforced composite like as, thermal degradation and kinetics of the untreated, alkali treated and sulphuric acid treated sugar cane bagasse (SB). It had been estimated by non-isothermal thermo gravimetric investigation under nitrogen atmosphere The alkali treated fabricated samples represent the maximum values of thermal degradation. FTIR and XRD established different functionalization with fiber surface and improved crystallinity. The NaOH treated sample exposed the maximum thermal stability with acid treated samples presented the lowest. Mohapatra, Mishra and Choudhary et. al. [4] was studied on teek wood dust (TWD) reinforced epoxy composite and thermal conductivity is analyzed. He used hand lay-up method for fabrication of composite with dust particle size 150, 200, 250-micronsand having volume fraction 6.5, 11.3, 26.8, 35.9. It was observed after experiment ,thermal conductivity of composite decreases with respect of increase in filler content. Experimental results (TWD,150µ) was also compared with the theoretical models (such as Rule of Mixture model, Russel model, Maxwell model Baschirow & Selenew model) and found that the errors associated of all models in respect of experimental ones lie with range of 20.14 to 84%, 74 to111.84%, 79.13 to 115.79% and60.13 +to 102% respectively. The newly developed composite materials can be used for application in automobile interior parts, electronic packages, ceiling roofs, building constructions, sports goods and furniture etc. [MoAn15]

Gouda et.al. research focused on wear study of sisal fiber reinforced epoxy based composite materials. LY-556 and HY 951 used as resin and hardener respectively. 10%, 20%, and 30% sisal fiber used as reinforcement during fabrication of composite by had lay-up method. By increasing the percentage of the sisal fiber in fabrication work enhance the weight loss of the specimen of wear test. SFRECM can be used as substitute materials for human Orthopedic Implants.[GPDHP14]

Karaduman, et. al. was studied of the viscoelastic properties of jute/ poly propylene nonwoven reinforced composites by dynamic mechanical analysis. The chemical treatment of fiber completed by alkali solution to obtain better adhesion property of the fiber-matrix interface. The degrees of highest storage modulus and loss modulus of nonwoven composites enhanced with increase in the jute fiber content [KSOR14].

Kumar, et. al. were focused with the study of flexural and tensile behavior of short Kenaf fiber reinforced composites. The fibers were chemically processed in 2% Noah solution at room temperature. The size of short fibers of 4mm and 8 mm are used in this work. The composite lamina was fabricated by hand molding method using isopthalic polyester resin. The Flexural test and tension tests were carried out as per ASTM standards. Fiber matrix weight ratio of 1:20 had been used. Three and one specimens were prepared for Short natural fiber composite laminate and water absorption tests as per ASTM standards respectively [KRS13].

Malaiah et. al. were studied on wear study of 2%, 24% and 36% of Hybrid Fiber (Natural fiber- Sisal, Jute and Hemp) reinforced with polymer composite material and can used as Bio-material. The characterization of 12%,24% & 36% of the natural fiber reinforced polymer composite material Contain the low density, economical for prosthetic bone in respect to biocompatibility and the mechanical behavior of long human bones, like as Femur Bone. The samples were prepared according to ASTM Standard G-99 by using resin- LY556 in the matrix and Hardener-HY 951 with the 12%, 24%and 36% of natural fibers (Sisal, Jute and Hemp) as reinforced material with fiber weight fraction, and randomly continuous long fiber orientation.

The hand lay-up fabrication technique was used to prepared the specimen. The wear test was conducted using pin-on-disk apparatus with was issued under the standard having ASTM G- 99 [SmMk13].

Srivastava and Choudhary investigated the suitability of natural and synthetic fiber reinforced hybrid composite to replace the leaf spring used in automobiles. The jute and E-glass fiber woven, roving, and mats were applying as the reinforcing element and epoxy resin LY556 consider as the matrix material. Also, the UNIGRAPHICS NX6 were used to develop CAD models of leaf spring and ANSYS 14.5 used to finite element analysis (FEA) studied. This work outcome represents optimum condition for design variables of the hybrid composite leaf spring by FEA. The weight of leaf spring reduced by 55% in comparison of the steel leaf spring. It was also concluded that the Jute/E-glass/Epoxy hybrid composite leaf spring was more economical than E-glass/Epoxy composite leaf spring [AsSc13].

Miller, et. al. investigation on development and behavior study of bio based composites. In this research work, bio based composites fabricated with different natural fiber reinforcement in a poly(b-hydroxybutyrate)-co-(bhydroxyvalerate) matrix. These composite through experiments and environmental impact basis of life cycle assessments. It was observed, flexural properties and thermal conductivity of certain short-chopped glass fiber reinforced plastics be comparable with natural fiber based composites. Multi-criteria material assortment procedures were adopted to weigh favorite material properties. The Flexural testing represent that the highly treated hemp fibers providing, higher strength and flexural properties of bio based composites than the low processed hemp fibers [MLB13].

Cerqueira, *et. al.* was studied on the composite material manufacturing using natural fiber as reinforce fibers. He was evaluated the effect of chemical amendment on mechanical behavior of sugarcane bagasse fiber reinforced in polypropylene based composites. The Fibers were treated with 10% sulfuric acid solution and followed by delignification by 1% NaOH solution. The tensile, flexural (3 – point bending), and impact test be studied of fabricated composites. The fracture analysis was performed using SEM (secondary electrons mode). The outcome of composite samples compares with pure polymer. This study shown cellulose based chemically modified from sugarcane bagasse has better property than chemically untreated fiber particle reinforced composites [CBM11].

Vishnu Prasada, et. al. studied on Jute and banana fiber hybrid polymer matrix composite are manufactured separately in laboratory. Cashew Nut Shell Resin Liquid [CNSL] is mixed with General purpose resin to get hybrid polymer and used as matrix for both jute and banana fiber composites. Varying CNSL percentage in hybrid polymer from 5% to 40% is carried out to fabricate composites so as to study the effect of the influence of CNSL in the hybrid polymer matrix composites. A new set of jute and banana fiber hybrid polymer matrix composite, combination of varying CNSL and general purpose resin matrix is obtained whose tensile strength is calculated at various combinations and best results are obtained using ANOVA technique. This natural fiber hybrid polymer matrix can replace many synthetic resin composites considering the recyclability and cost factors [VAGSS18].

CHAPTER THREE
FUZZY SET THEORY AND TOPSIS METHOD

<u>3.1 An introduction to Fuzzy Logic</u>

Fuzzy logic (FL) was conceived by Lotfi Zadeh, at University of California at Berkley, and presented as a way of processing data by allowing Partial set membership rather than crisp membership or no membership, it has been presented as processing method for data rather than control methodology at first. Later in 70's due to the low sufficiency of computers this set theory was not applied at that time.

The concept of fuzzy logic is the uncertainty that makes control system yet efficient rather than Boolean switch. Professor Zadeh reasoned that people do not require precise, number of inputs, and yet they are capable of highly adaptive control. If feedback controllers could be programmed to accept noisy, imprecise input, they would be much more effective and perhaps easier to implement. This logic was not around in U.S manufacturers while Europeans and Japanese have been building products on it.FL is a problem solving control system methodology that is implemented in small scale micro-chips to large networks and multi-channel PC control systems. It can be applied on hardware, software, or both. FL provides an easy way to arrive the result from imprecise or noisy missing input information.

FL uses a simple rule of (IF X AND Y THEN Z) approach to a solving control problem rather than modeling a system mathematically. FL is based on operator's experience rather than their technical understanding of the system. For example, consider what you do in the shower if the temperature is too cold: you will make the water comfortable very quickly with little trouble. This would look like this in classical logic system control:

SP= 500F, T<1000F, or 210C<TEMP<220C, by attempting to use rules like:

"IF (process is too cool) AND *(process is getting colder)* THEN *(add heat to the process)"*

Or

"IF (process is too hot) AND *(process is heating rapidly)* THEN *(cool the process rapidly)".*

Some numerical parameters is needed to operate FL system, such as what is considered significant error and significant rate of chane of error, but exact values of these numbers are usually not critical unless very responsive performance is required in which case empirical tuning would determine them. A simple temperature control system could use a temperature sensor whose data is subtracted from the command signal to computer ""error" and then time differentiated to yield the rror slope or rate of change of error, which is called "error-dot". The values don't have to be symmetrical and can be "tweeked" once the system is operating in order to optimize performance.

Generally, FL is so forgiving that the system will probably work the first time without any tweaking. FL is a better method for sorting and handling data also proven to be the choice for many control systems. FL is attempting to mimic control logics of human control logic. it uses an imprecise but very descriptive language to deal with input data more like a human operator. It is very robust and forgiving of operator and data input and often works when first implemented with little or no tuning. Unique features of FL makes it particularly good choice for many control problems, it has some **advantages** like:

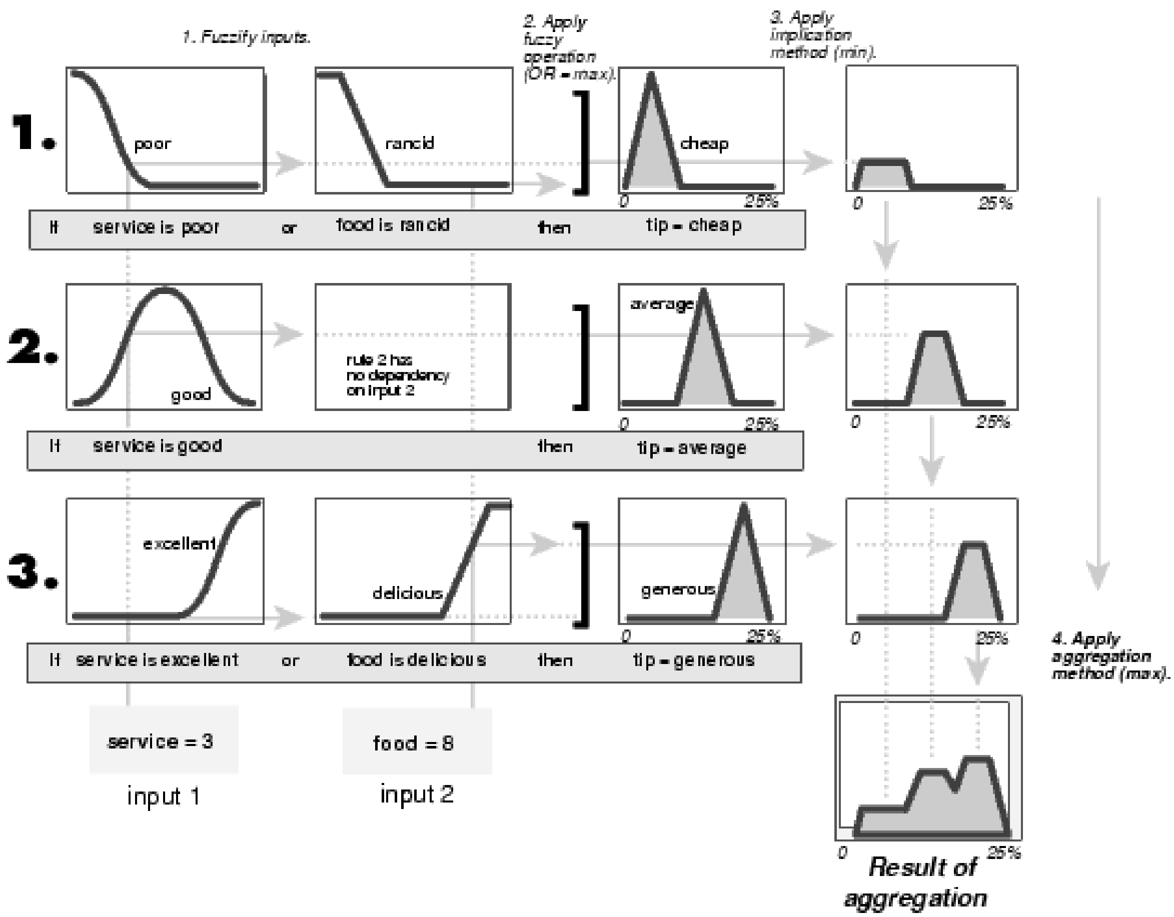
- Define the control criteria: what I need to control? What to do for that particular control system? What I need in response? And probabilities failure modes.
- Choose a minimum number of inputs to FL engine and determine the input output relationships, relationships resulted in error and rate of change error.

- Breaking down the control system into simple (IF X AND Y THEN) rules that a system output response for given input conditions. Rules complexity depends on the number of inputs and input parameters that need to be processed and the number of fuzzy variables associated with each parameter. It's possible to use single error parameter or at least one variable and its time derivative without knowing the rate of change of the error. [LeKe99]
- Rules define input/output terms that functions implement to make FL membership.
- Implement S/W. or program the rules intro FL H/W engine, this type of pre- and post-processing FL is typically implemented.

In FL, you have to decide exactly what should be controlled and how.

The rule matrix is a graphical tool for mapping FL control system variables. To use, define system inputs, decide output conclusions, and load these into the rule matrix. There is membership function (MF) related to input parameter. The effectiveness of a rule is related to weight of the rule and the value of each input. The weighting of a function influences the result of the rule or degree of membership (DOM) i.e. how much that parameter affects the result by the rule that process the data. Fuzzy output is produced by computing logical product of the membership weight of each rule. [LeKe999]

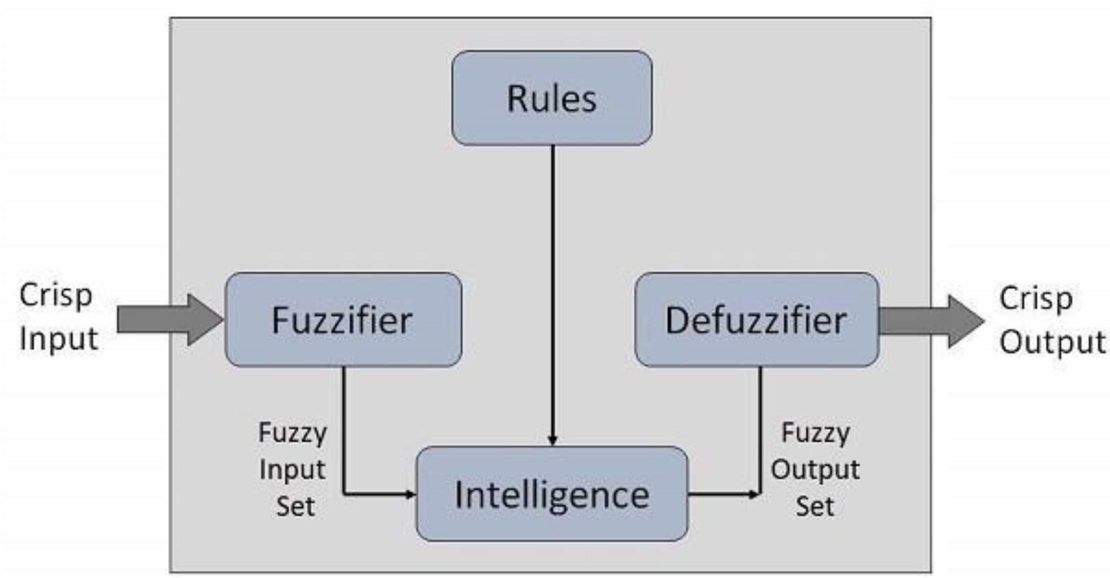
Fig. 2 demonstrates some functions that simplify the logic, There is functions that describe the situation of the input variable that repeats over a period of time or depending on a fuzzy foundation.



Fig(2): FL Example

Functions can be implemented depending on the repetition of the variable and their complexity. Triangular functions are common, but bell, trapezoidal, haversine and, exponential have been used. Height, width, center points, overlap are from the properties of the membership functions. The height represents the magnitude (normalized to 1), width is the base of the function, shouldering is locking the

Height at maximum of an outer function. Center point is the center of the member function shape. And overlap is typically %50 or less of the width of the shape)



Fig(3): Fuzzy Inference System

Membership functions can be applied on inputs and outputs as well to act their true behavior in simulation, to mimic their real-world values. Fuzzy systems are more human like solution for real world problems in any situation. Crips data inputs into the system which is well known and the fuzzier (conditions and the rest of unknown variables) expands the fuzzy area around the subject or matter. A set of data is collected from the crisp input and in turn the fuzzier. Rules are the impossibilities that could happen or will happen during the process and the condition taken in the term of (if X and Y then Z), the intelligence node shown in fig.2 will give a batch of data analyzed through fuzzy functions previously set by the end-user and crisp outputs generated from the defuzzifier. [Madau996]

3.2 An introduction to Multi-Criteria Decision Analysis

Multi-Criteria Decision Analysis, or MCDA, is a valuable tool that we can apply to many complex decisions. It is most applicable to solving problems that are characterized as a choice among alternatives Multiple criteria decision making (MCDM) refers to making decisions in the presence of multiple, usually conflicting, criteria. The existing approaches are limited because of unquantifiable and incomplete information in typical environment. Furthermore, the fuzziness and vagueness of human judgment and preference make the approaches difficult to be applied in practice. In this paper we present a new multi-criteria group decision making approach employing fuzzy theory using linguistic values and entropy-based criteria weighting.

An illustrative example is shown to demonstrate the effectiveness of the proposed scheme. Problems for multiple criteria decision making are common occurrences in everyday life. For example: In a personal context, the job one chooses may depend upon its prestige, location, salary, advancement opportunities, working conditions, and so on. The car one buys may be characterized in terms of price, gas mileage, style, safety, comfort, etc. A young man/woman may choose a wife/husband based on her/his intelligence, locks, character, etc. In a business context, a business executive's choice of corporate strategy may depend on the company's earnings over a period of time, its stock price, share of market, goodwill, labor relations, corporate image, obligation to society, and so forth. Automobile manufacturers in Detroit want to design a model which maximizes fuel efficiency, maximizes riding comfort, minimizes production cost, etc. In an academic context, a university administrator's selection of the future configurations of the university would be based on number of regular faculty, number of auxiliary faculty, undergraduate enrollment, graduate en-rollment, tuition level, faculty leverage, new programs, and net improvement, etc. In a public context, the water resources development plan for a community should be evaluated in terms of cost, probability of water shortage, energy (reuse factor), recreation, flood protection, land and forest use, water quality, etc. [JLI06]

3.3 Procedures of topsis are as following:

TOPS IS (Technique for Order Preference by Similarity to the Ideal Solution)

1) Establish the normalized decision matrix.

2) Determine the ideal solution and negative ideal solution.

3) Calculate the distance from the ideal and negative ideal solution for each alternative.

4) Calculate the relative closeness to the ideal solution for each alternative.

5) Rank the preference order.

In this method two artificial alternatives are hypothesized:

• Ideal alternative: the one which has the best level for all attributes considered. • Negative ideal alternative: the one which has the worst attribute values.

• TOPSIS selects the alternative that is the closest to the ideal solution and farthest from negative ideal alternative.

• TOPSIS assumes that we have m alternatives (options) and n attributes/criteria and we have the score of each option with respect to each criterion.

• Let x_{ii} score of option i with respect to criterion j we have a matrix $X = (x_{ij})_{mxn}$ matrix.

• Let J be the set of benefit attributes or criteria (more is better)

• Let J' be the set of negative attributes or criteria (less is better)

3.4 STEPS OF TOPSIS

- Step 1: Construct normalized decision matrix.

Normalize scores or data as follows:

$r_{ij} = x_{ij} / \sqrt{(\Sigma x^2_{ij})}$ for $i = 1, \ldots, m; j = 1, \ldots, n_i$

- Step 2: Construct the weighted normalized decision matrix

An element of the new matrix is:

$v_{ij} = w_j \, r_{ij}$

- Step 3: Determine the ideal and negative ideal solutions

$A^* = \{ v_1^* , \ldots, v_n^* \}$, where

$v_j^* = \{ \max (v_{ij}) \text{ if } j \in J ; \min (v_{ij}) \text{ if } j \in J' \} i \, i$

Negative ideal solution:

$A' = \{ v_1' , \ldots, v_n' \}$, where

$v' = \{ \min (v_{ij}) \text{ if } j \in J ; \max (v_{ij}) \text{ if } j \in J' \}_{i \, i}$

- Step 4: Calculate the separation measures for each alternative

$Si^* = [(v_j^* - v_{ij})^2]^{½} \quad i = 1, \ldots, mj$

Similarly, the separation from the negative ideal alternative is:

$S'i = [(v_j' - v_{ij})^2]^{½} \quad i = 1, \ldots, m$

- Step 5: Calculate the relative closeness to the ideal solution Ci*

$Ci^* = S'_i / (S_i^* + S'_i) , < C_i^* < 1$

Select the Alternative with Ci* closest to 1. [JLI06]

CHAPTER FOUR

COMPARATIVE ANALYSES AND DISCUSSION

4.1 Analyses

Getting data from (Finite Element analysis of jute and banana fiber reinforced hybrid polymer matrix composite and optimization of design parameters using ANOVA technique [VAGS18] , Optimizing the delamination failure in bamboo fiber reinforced polyester composite [AbSi16]) and calculate by Fuzzy logic and Topsis method.

First research: Finite Element Analysis of Jute and Banana Fiber Reinforced Hybrid Polymer Matrix Composite and Optimization of Design Parameters Using ANOVA Technique [VAGS18].

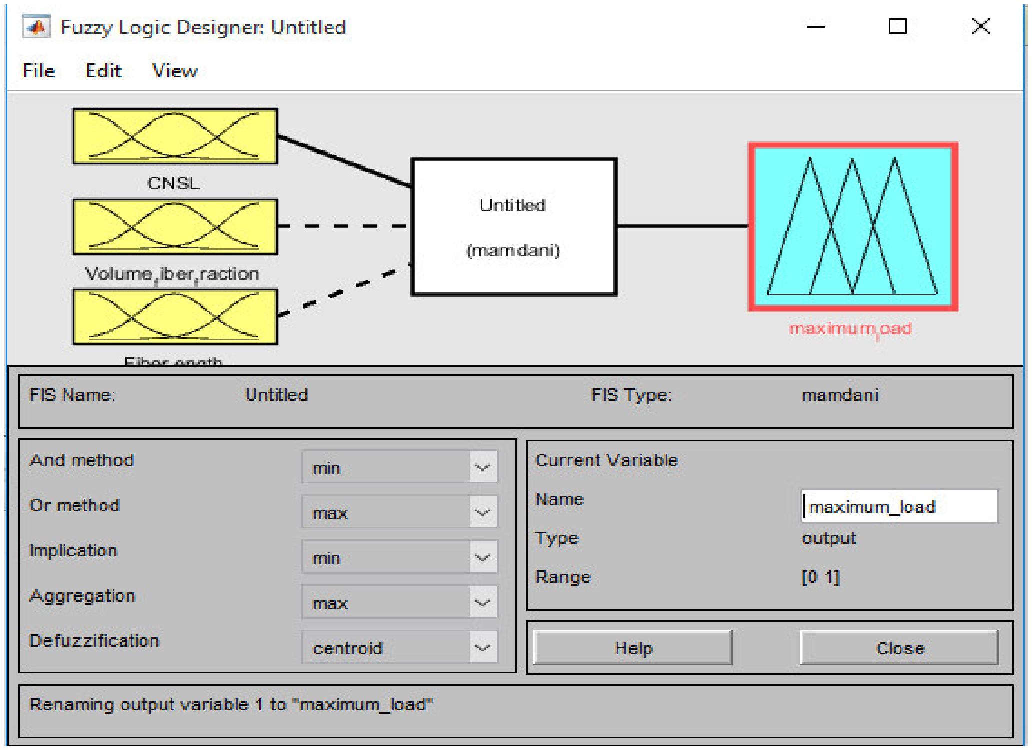
Jute and banana fiber hybrid polymer matrix composite are manufactured separately in laboratory. Cashew Nut Shell Resin Liquid [CNSL] is mixed with General purpose resin to get hybrid polymer and used as matrix for both Jute and banana fiber composites. Varying CNSL percentage in hybrid polymer from 5% to 40% is carried out to fabricate composites so as to study the effect of the influence of CNSL in the hybrid polymer matrix composites

Jute fiber

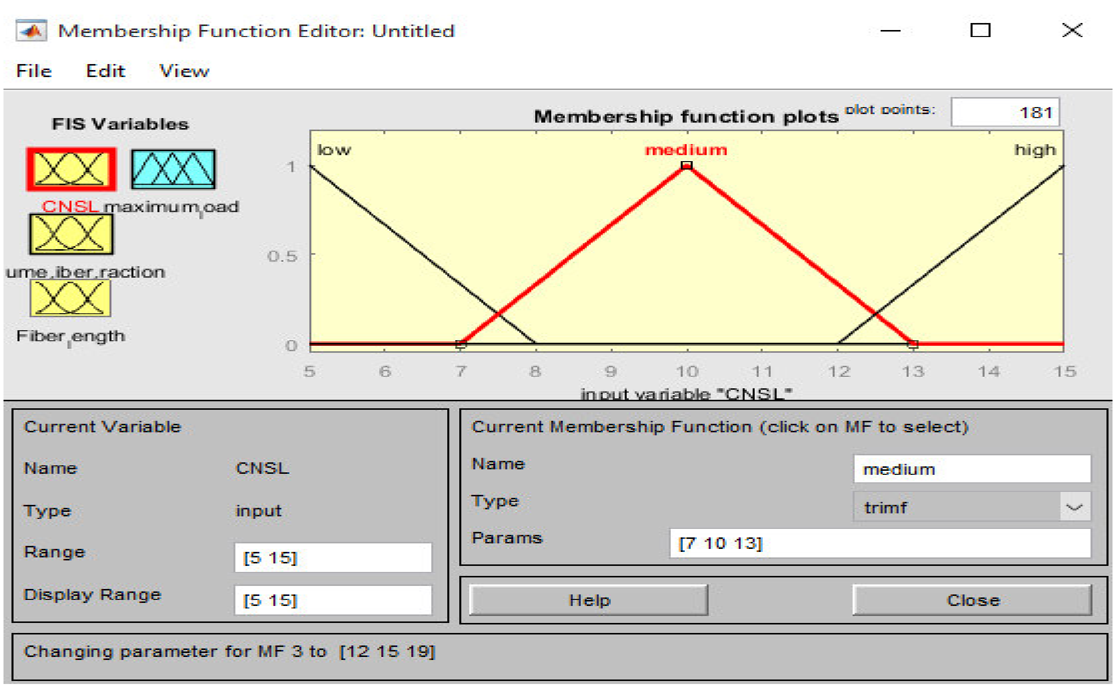
Table 1: 9 orthogonal array with 3 factors, 3 response

array	CNSL%	Fiber volume fraction%	Fiber length	Maximum load
1	5	20	1	1321
2	5	30	2	1560
3	5	40	3	1630
4	10	20	2	1085
5	10	30	3	1050
6	10	40	1	1388
7	15	20	3	660
8	15	30	1	862
9	15	40	2	880

Putted input and output into matlab

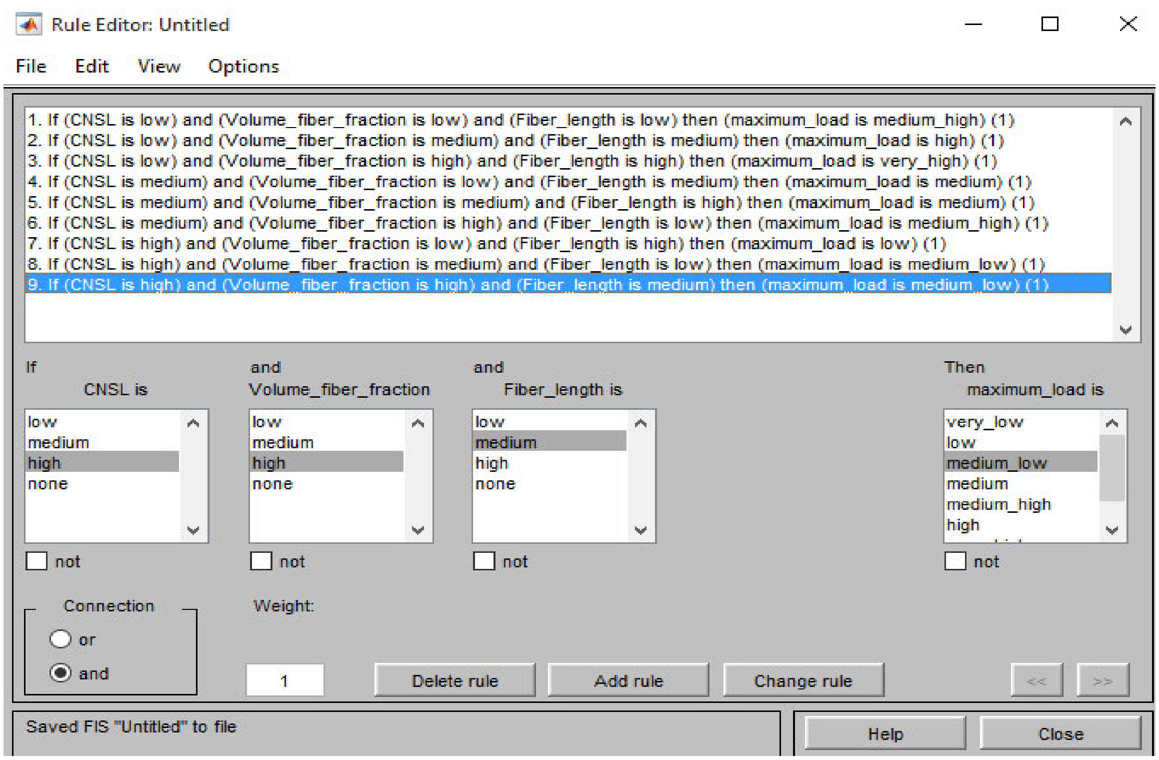


Fig(4) input and output



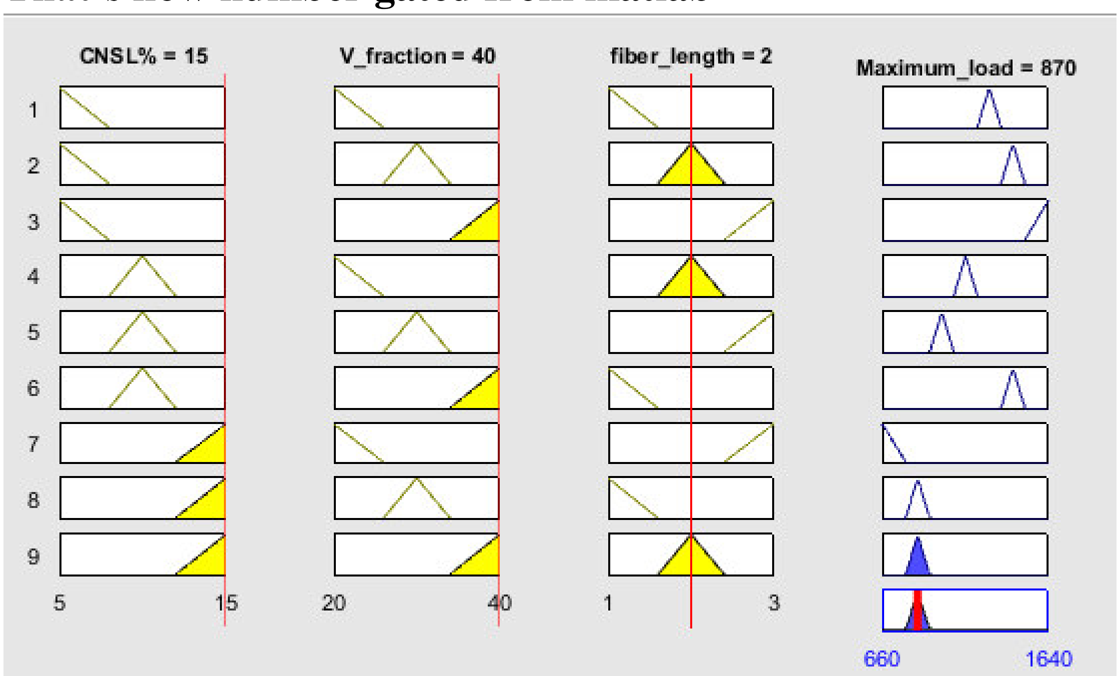
Fig(5) membership function

Rules



Fig(6) Rules of fuzzy

That's how number gated from matlab

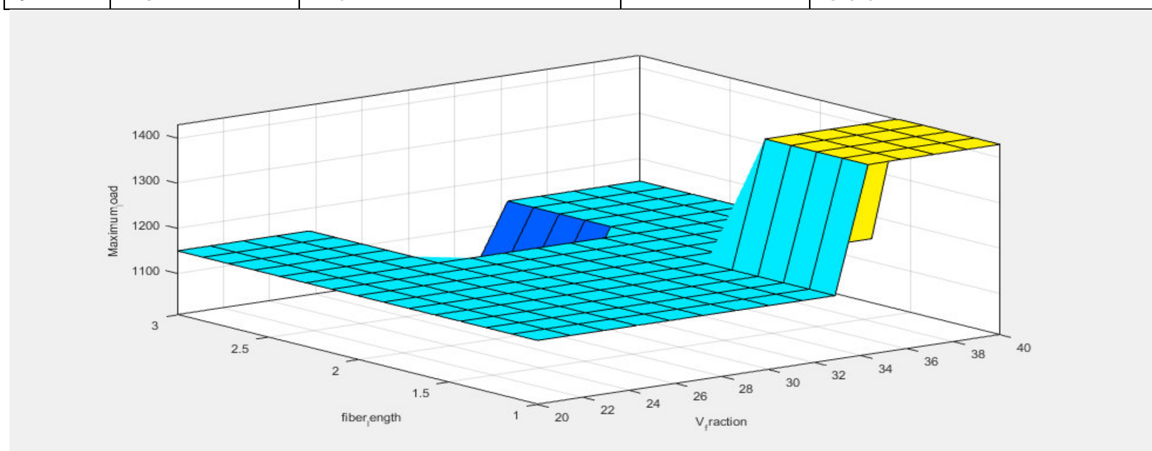


Fig(7) fuzzy example

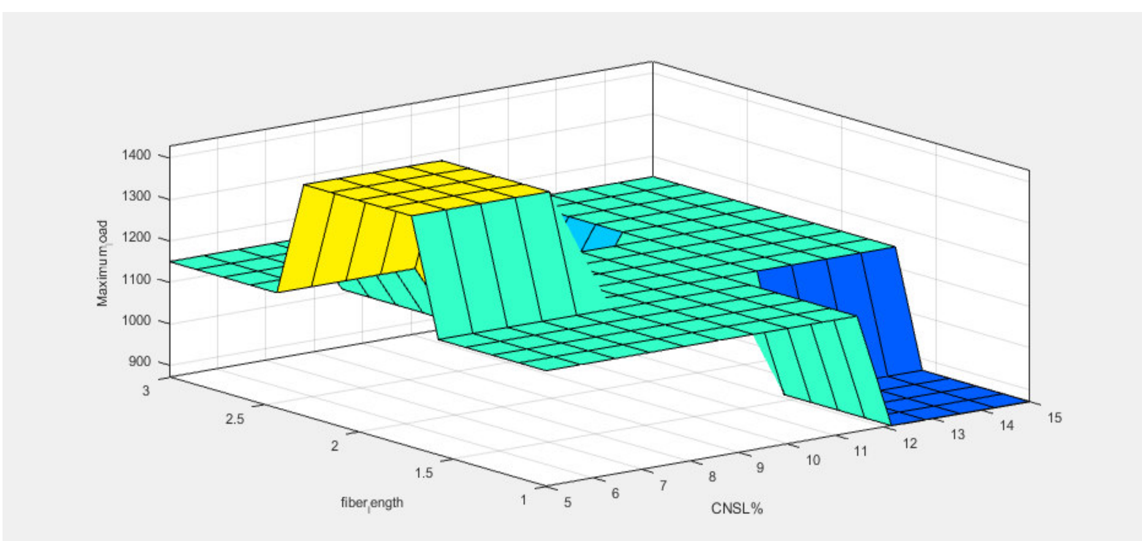
Calculated data by fuzzy tool in matlab

Table 2: 9 orthogonal array with 3 factors, 3 response

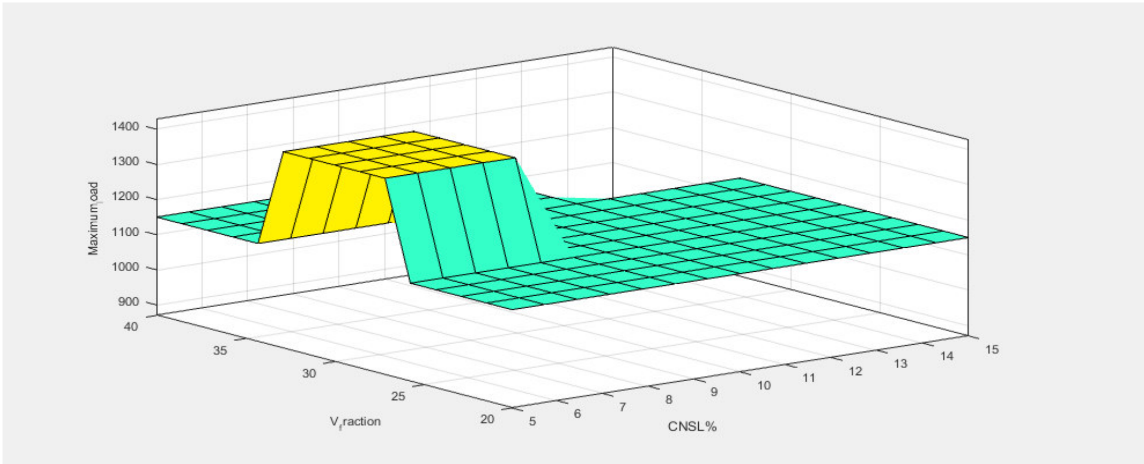
array	CNSL%	Fiber volume fraction%	Fiber length	Maximum load by Fuzzy
1	5	20	1	1310
2	5	30	2	1500
3	5	40	3	1620
4	10	20	2	1100
5	10	30	3	1070
6	10	40	1	1400
7	15	20	3	703
8	15	30	1	870
9	15	40	2	880



(a)



(b)



(c)

Fig (8)a-c: Surface plots

For banana fiber

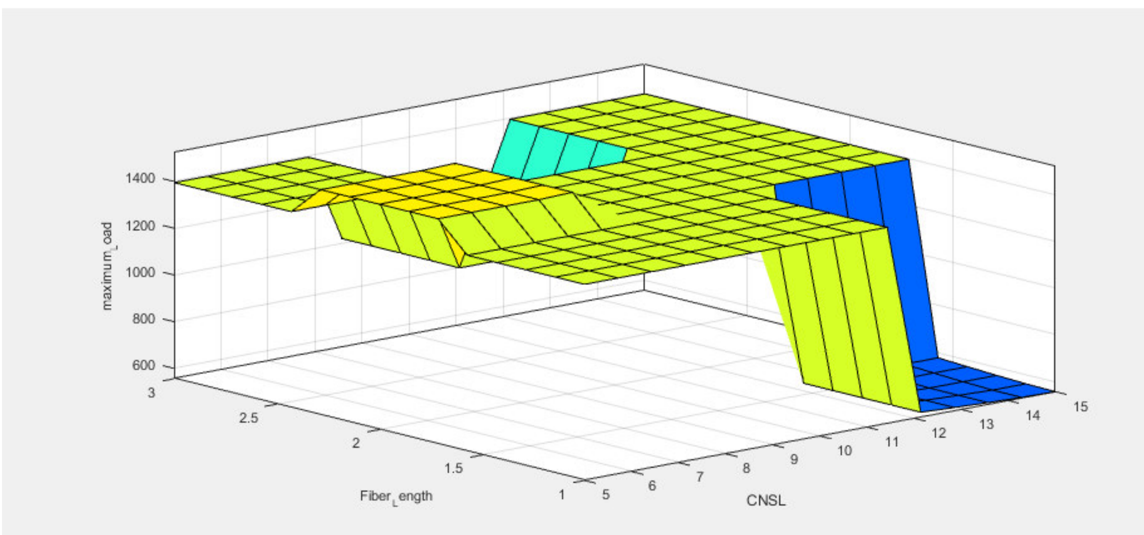
Table 3: 9 orthogonal array with 3 factors, 3 response

Array	CNSL%	Fiber volume fraction%	Fiber length	Maximum load
1	5	10	1	2245
2	5	20	2	1578
3	5	30	3	1289
4	10	10	2	1200
5	10	20	3	991
6	10	30	1	525
7	15	10	3	814
8	15	20	1	635
9	15	30	2	520

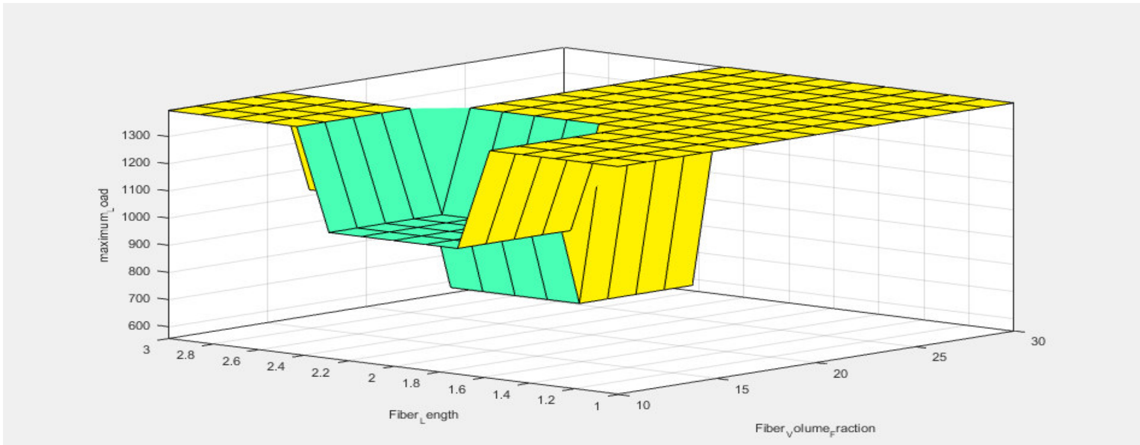
Calculation by fuzzy

Table 4: computation 9 orthogonal array with fuzzy

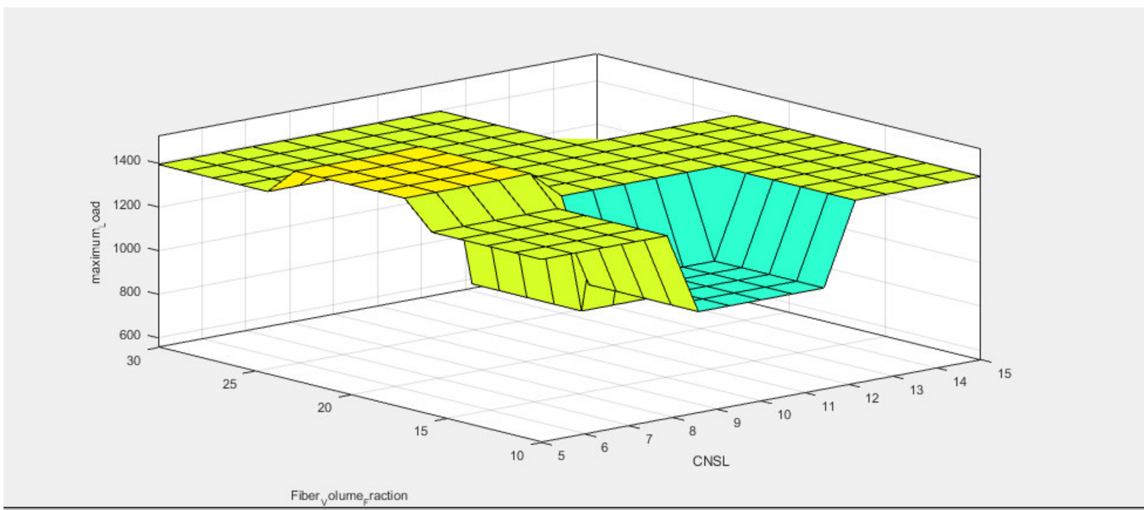
Array	CNSL%	Fiber volume fraction%	Fiber length	Maximum load by Fuzzy
1	5	10	1	2250
2	5	20	2	1535
3	5	30	3	1280
4	10	10	2	1190
5	10	20	3	1000
6	10	30	1	560
7	15	10	3	770
8	15	20	1	580
9	15	30	2	536



(a)



(b)



(c)

Fig (9) a-c surface plot

Optimization of TOPSIS method for both fibers (alternatives are experiments 1-9, attributes are max load for jute and max load for banana).

The one that gives maximum for both materials is the optimum. TOPSIS thus gives a solution that is not only closest to the hypothetically best, that is also the farthest from the hypothetically worst. The main procedure of the TOPSIS method for the selection of the best alternative from among those available is described below:

Step 1: First normalize attributes (max load for jute and banana)

Step 2: Decide on the relative importance (i.e., weights) of different attributes with respect to the objective. A set of weights (Ra and MRR)

wj (for j=1, 2, ….. , M) such that ∑wj =1 may be decided upon.

Step 3: Obtain the distance measures. The distance of each alternative from the ideal one is given by the Euclidean distance in the following equations.

Si + ={$\sum_{J=1}^{M}$ (Vij - Vj +)2 }^0.5 , i = 1, 2, …., N

Si - = {$\sum_{J=1}^{M}$ (Vij - Vj -)2 }^0.5 , i = 1, 2, …., N

Step 4: The relative closeness of a particular alternative to the ideal solution, Pi, can be expressed in this step as follows.

Pi = Si - / (Si + + Si -) [JLI06]

Table 5: calculation of 9 experiment with TOPSIS method

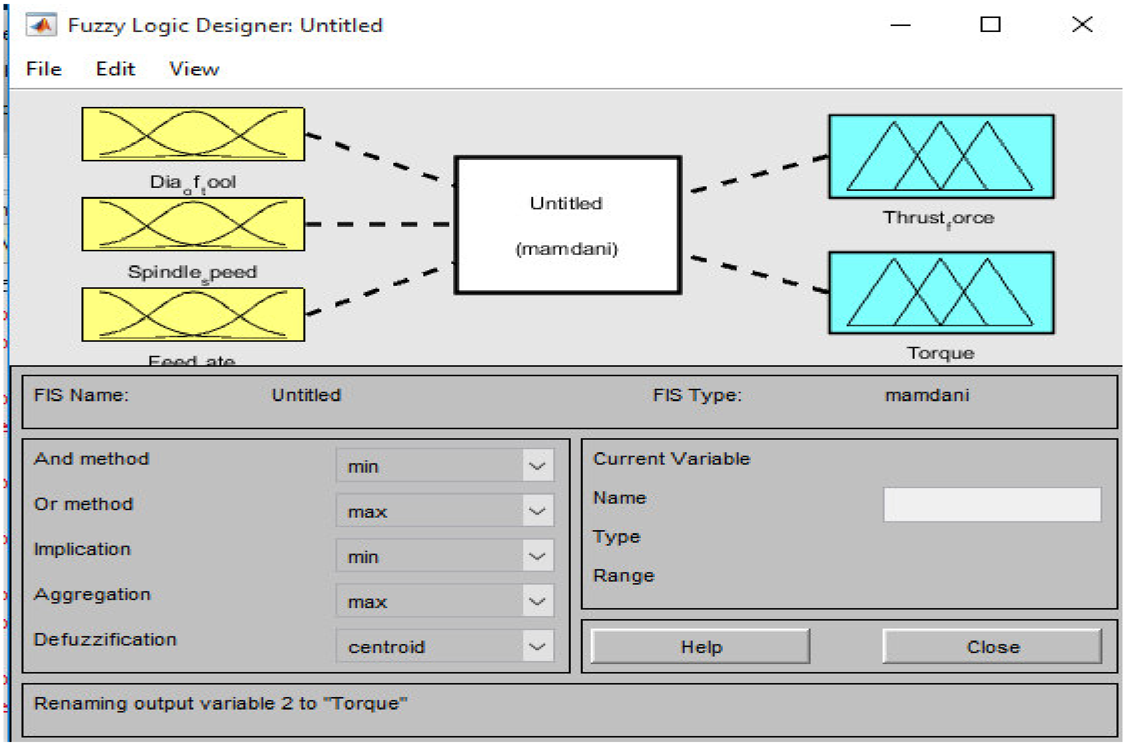
data			Multiplication by weight		Distance measure		Closeness	S/N
NO.	Banana	Jute	Ra	MRR	S plus	S minus	coeff.	Ratio
1	1	0.661941	0.5	0.3309705	0.52779823	0.3309705	0.614598799	4.228165854
2	0.582847	0.869138	0.2914235	0.434569	0.298678543	0.482031505	0.382572946	8.345714898
3	0.434072	1	0.217036	0.5	0.217036	0.574515992	0.274190454	11.23895339
4	0.381563	0.432933	0.1907815	0.2164665	0.341743802	0.377457052	0.475171574	6.462990954
5	0.270711	0.400218	0.1353555	0.200109	0.329022375	0.415943774	0.44166084	7.098222123
6	0.014002	0.760087	0.007001	0.3800435	0.120160625	0.62247978	0.161801896	15.82032788
7	0.136522	0	0.068261	0	0.504638053	0.431739	0.538926121	5.369415328
8	0.02567	0.182115	0.012835	0.0910575	0.409143869	0.495601862	0.452219729	6.893009897
9	0	0.19302	0	0.09651	0.40349	0.509229006	0.442074721	7.090086364
		Min=ideal Ra	0					
		Max=N.ideal Ra	0.5					
		Max=ideal Mrr	0.5					
		Min=N.ideal Mrr	0					

SECOND RESEARCH:

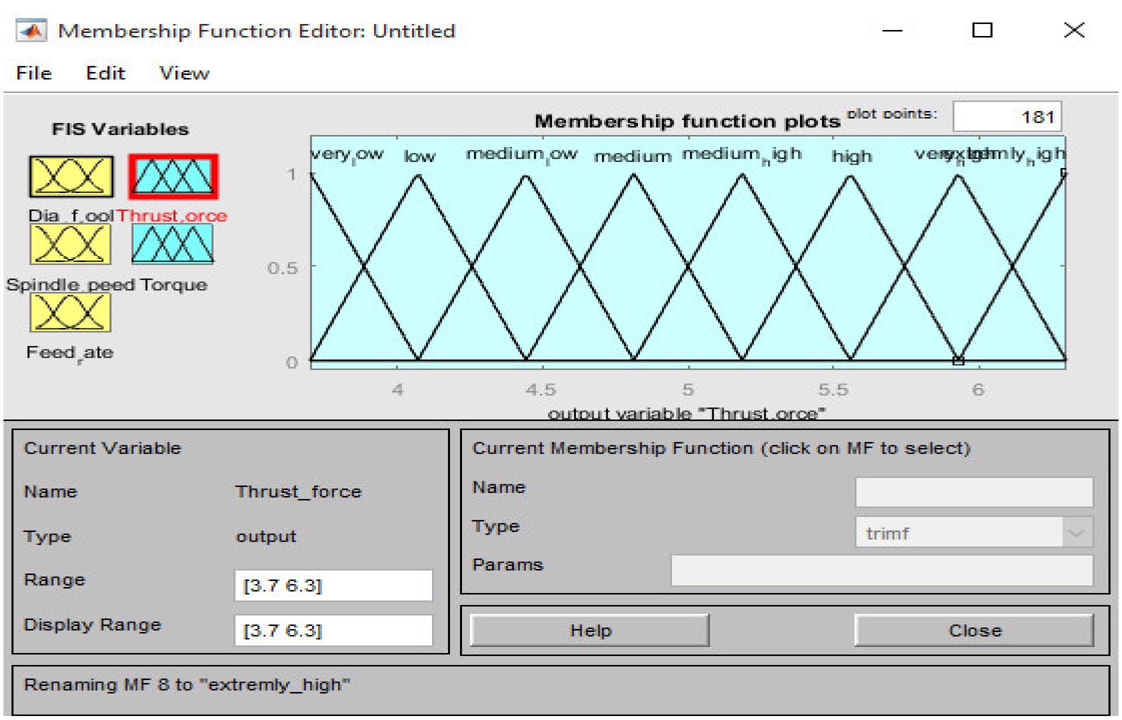
Table 6: 18 orthogonal array with measured output.

Array	Dia of tool (mm)	Spindle speed (RPM)	Feed rate (mm/min)	Thrust Force (N)	Torque (Nm)
1	4	500	18	4.847	1.3
2	4	860	26	4.917	1.404
3	4	1360	34	5.001	1.349
4	6	500	18	3.723	1.254
5	6	860	26	4.571	1.285
6	6	160	34	5.041	1.261
7	8	500	26	5.07	1.389
8	8	860	34	4.988	1.405
9	8	1360	18	5.056	1.311
10	4	500	34	4.411	1.332
11	4	860	18	4.112	1.317
12	4	1360	26	4.988	1.365
13	6	500	26	4.225	1.311
14	6	860	34	6.295	1.577
15	6	1360	18	5.182	1.281
16	8	500	34	5.698	1.315
17	8	860	18	4.217	1.459
18	8	1360	26	5.117	1.469

Putted input and output into Matlab

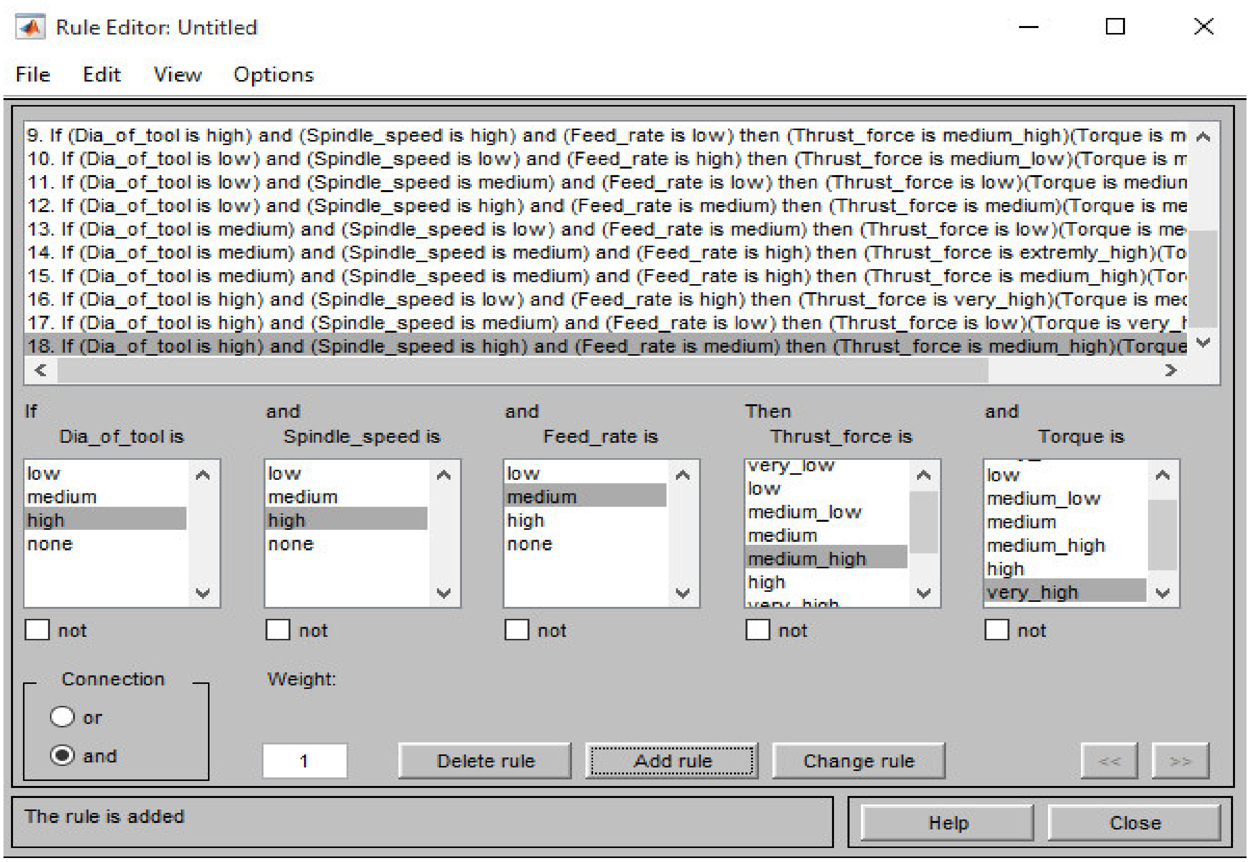


Fig(10) input and ottput



Fig(11)

Rules



Rule Editor: Untitled
File Edit View Options
9. If (Dia_of_tool is high) and (Spindle_speed is high) and (Feed_rate is low) then (Thrust_force is medium_high)(Torque is m
10. If (Dia_of_tool is low) and (Spindle_speed is low) and (Feed_rate is high) then (Thrust_force is medium_low)(Torque is m
11. If (Dia_of_tool is low) and (Spindle_speed is medium) and (Feed_rate is low) then (Thrust_force is low)(Torque is mediun
12. If (Dia_of_tool is low) and (Spindle_speed is high) and (Feed_rate is medium) then (Thrust_force is medium)(Torque is me
13. If (Dia_of_tool is medium) and (Spindle_speed is low) and (Feed_rate is medium) then (Thrust_force is low)(Torque is me
14. If (Dia_of_tool is medium) and (Spindle_speed is medium) and (Feed_rate is high) then (Thrust_force is extremly_high)(To
15. If (Dia_of_tool is medium) and (Spindle_speed is medium) and (Feed_rate is high) then (Thrust_force is medium_high)(Tor
16. If (Dia_of_tool is high) and (Spindle_speed is low) and (Feed_rate is high) then (Thrust_force is very_high)(Torque is mec
17. If (Dia_of_tool is high) and (Spindle_speed is medium) and (Feed_rate is low) then (Thrust_force is low)(Torque is very_l
18. If (Dia_of_tool is high) and (Spindle_speed is high) and (Feed_rate is medium) then (Thrust_force is medium_high)(Torque
If Dia_of_tool is
low medium high none
and Spindle_speed is
low medium high none
and Feed_rate is
low medium high none
Then Thrust_force is
very_low low medium_low medium medium_high high
and Torque is
low medium_low medium medium_high high very_high
not
Connection
or
and
Weight:
1
Delete rule
Add rule
Change rule
<<
>>
The rule is added
Help
Close

Fig(12)

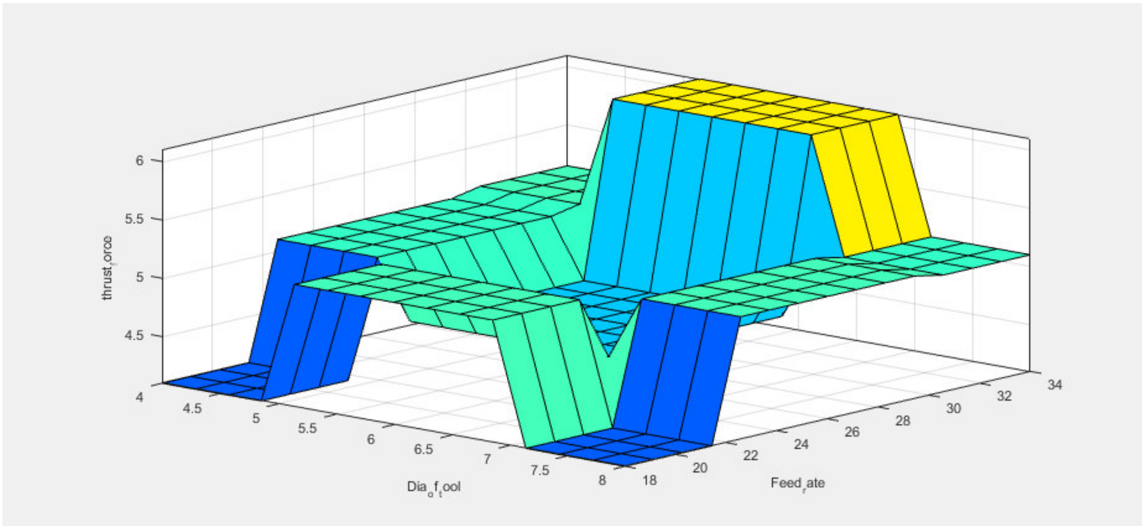
That's how number gated from Fuzzy tool in Matlab

Fig(13)

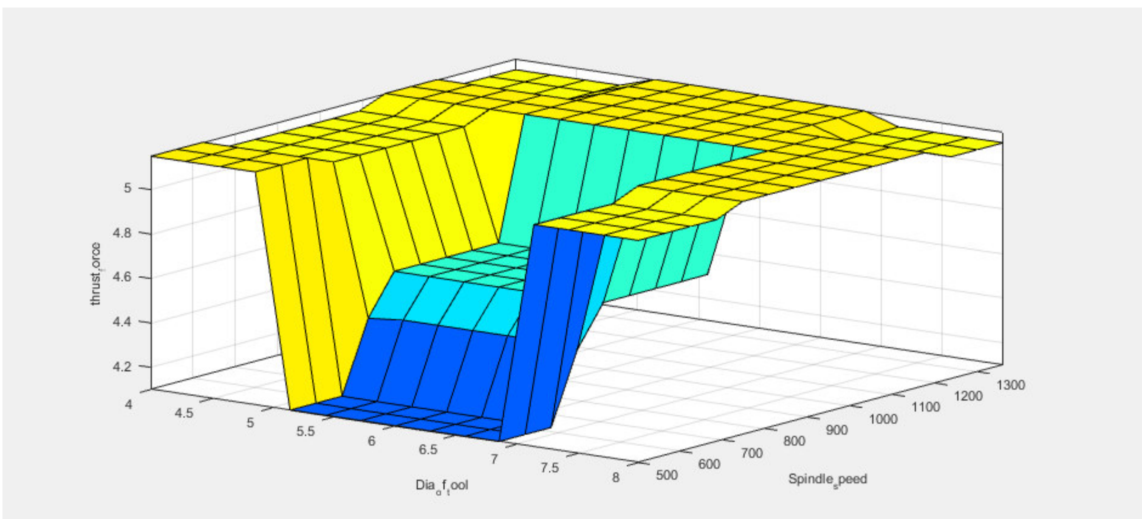
CALCULATION BY FUZZY

Table 7: 18 array with computation by fuzzy

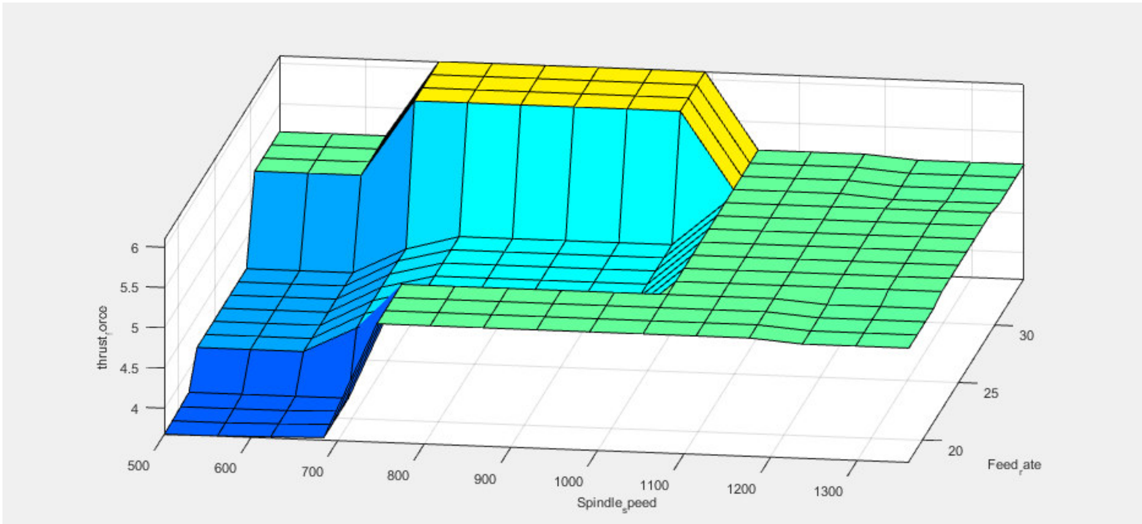
Array	Dia of tool (mm)	Spindle speed (RPM)	Feed rate (mm/min)	Thrust Force (N) by Fuzzy	Torque (Nm) By Fuzzy
1	4	500	18	4.6	1.26
2	4	860	26	5.00	1.38
3	4	1360	34	5.1	1.28
4	6	500	18	3.67	1.26
5	6	860	26	4.6	1.26
6	6	160	34	5.1	1.26
7	8	500	26	5.1	1.34
8	8	860	34	5.1	1.34
9	8	1360	18	5.1	1.3
10	4	500	34	4.6	1.3
11	4	860	18	4.1	1.26
12	4	1360	26	5.1	1.34
13	6	500	26	4.1	1.26
14	6	860	34	6.1	1.59
15	6	1360	18	5.1	1.28
16	8	500	34	5.6	1.34
17	8	860	18	4.1	1.43
18	8	1360	26	5.1	1.51


thrust_force
6
5.5
5
4.5
4
4.5
5
5.5
6
6.5
7
7.5
8
Dia_of_tool
18
20
22
24
26
28
30
32
34
Feed_rate

(a)

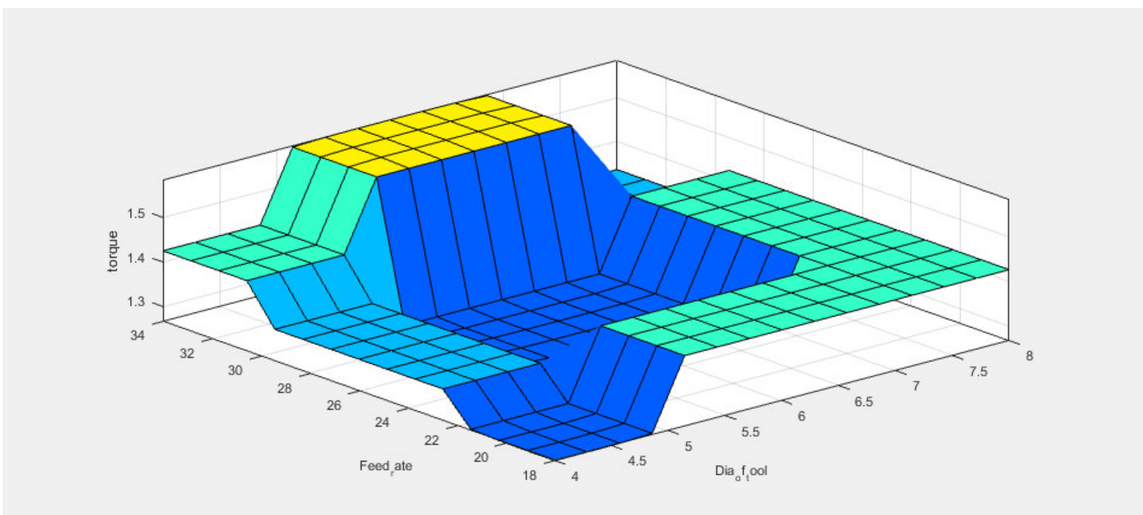

thrust_force
5
4.8
4.6
4.4
4.2
4
4.5
5
5.5
6
6.5
7
7.5
8
Dia_of_tool
500
600
700
800
900
1000
1100
1200
1300
Spindle_speed

(b)



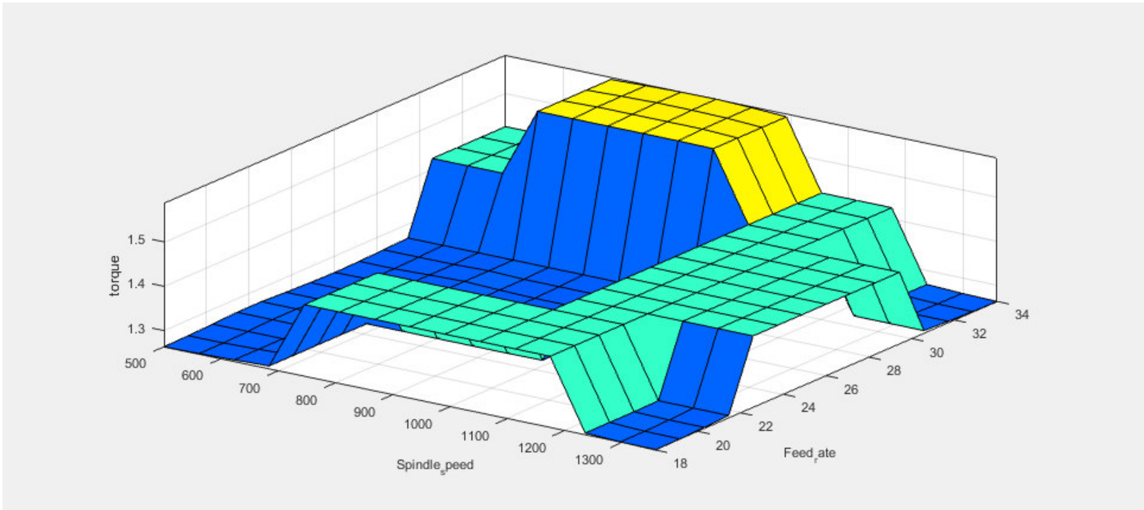
6
5.5
5
4.5
4
thrust_force
500
600
700
800
900
1000
1100
1200
1300
Spindle_speed
20
25
30
Feed_rate

(c)

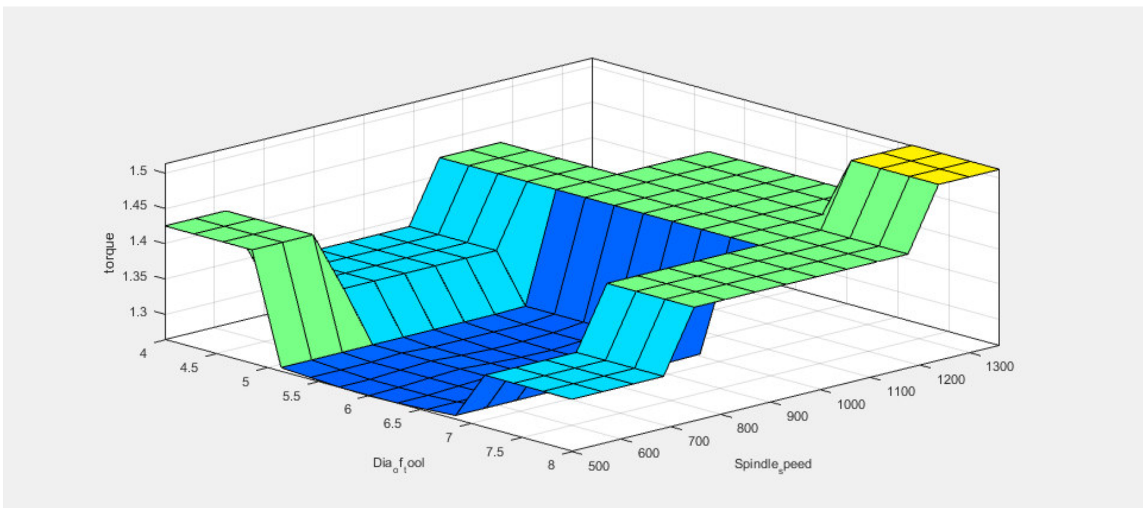


1.5
1.4
1.3
torque
34
32
30
28
26
24
22
20
18
Feed_rate
4
4.5
5
5.5
6
6.5
7
7.5
8
Dia_of_tool

(d)



(e)



(f)

Fig(14)a-f Surface plot

Optimization of TOPSIS method for both dependents (thrust force and torque):

The main procedure of the TOPSIS method for the selection of the best alternative from among those available is described below:

Step 1: First normalize attributes both (thrust force and torque)

Step 2: Decide on the relative importance (i.e., weights) of different attributes with respect to the objective. A set of weights (Ra and MRR)

wj (for j=1, 2, ….. , M) such that ∑wj =1 may be decided upon.

Step 3: Obtain the distance measures. The distance of each alternative from the ideal one is given by the Euclidean distance in the following equations.

Si + = $\{\sum_{J=1}^{M}$ (Vij - Vj +)2 }^0.5 , i = 1, 2, …., N

Si - = $\{\sum_{J=1}^{M}$ (Vij - Vj -)2 }^0.5 , i = 1, 2, …., N

Step 4: The relative closeness of a particular alternative to the ideal solution, Pi, can be expressed in this step as follows.

Pi = Si - / (Si + + Si -)

Table 8: 18 array with TOPSIS method calculation

data			Multiplication by weight		Distance measure		Closeness coeff.	S/N Ratio
NO.	Thrust force	Torque	Ra	MRR	S plus	S minus		
1	0.382716	0	0.191358	0	0.53536706	0.308642	0.63431435	3.953909269
2	0.547325	0.363636	0.2736625	0.181818	0.41967958	0.290321286	0.591097279	4.566820803
3	0.588477	0.060606	0.2942385	0.030303	0.55424865	0.207980929	0.727141357	2.767623073
4	0	0	0	0	0.5	0.5	0.5	6.020599913
5	0.382716	0	0.191358	0	0.53536706	0.308642	0.63431435	3.953909269
6	0.588477	0	0.2942385	0	0.58015196	0.2057615	0.738188095	2.636659266
7	0.588477	0.242424	0.2942385	0.121212	0.4796422	0.238809849	0.66760503	3.509608
8	0.588477	0.242424	0.2942385	0.121212	0.4796422	0.238809849	0.66760503	3.509608
9	0.588477	0.121212	0.2942385	0.060606	0.52881318	0.214501473	0.711425745	2.957408459
10	0.382716	0.121212	0.191358	0.060606	0.4792546	0.314536121	0.603754349	4.382794559
11	0.176954	0	0.088477	0	0.50776784	0.411523	0.552347329	5.155754835
12	0.588477	0.242424	0.2942385	0.121212	0.4796422	0.238809849	0.66760503	3.509608
13	0.176954	0	0.088477	0	0.50776784	0.411523	0.552347329	5.155754835
14	1	1	0.5	0.5	0.5	0.5	0.5	6.020599913
15	0.588477	0.060606	0.2942385	0.030303	0.55424865	0.207980929	0.727141357	2.767623073
16	0.794238	0.242424	0.397119	0.121212	0.54880219	0.158986946	0.775375268	2.209761117
17	0.176954	0.515151	0.088477	0.2575755	0.25806553	0.485485651	0.347071643	9.191617374
18	0.588477	0.757575	0.2942385	0.3787875	0.31822754	0.431065848	0.424703518	7.438282824
		Min=ideal Ra	0					
		Max=N.ideal Ra	0.5					
		Max=ideal Mrr	0.5					
		Min=N.ideal Mrr	0					

CONCLUSION

A new set of reinforcing jute and banana fiber hybrid polymer matrix composites, the result expose that the jute has high tensile strength but low bending combined with banana has high flexural strength for this reason combining jute and banana for manufacturing hybrid fiber also by changing the percent of fiber and matrix mechanical properties will be changed, by applying statistical analysis and computational approach to optimizing (CNSL matrix, fiber length, Volume fraction) with(Thrust force, torque, Surface roughness, material removal rate, s plus, s minuses, closeness coefficient, S/N Ratio) for manufacturing and design robustness product.

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