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Gandhinagar University, established under the Gujarat Private Universities Act, 2009 is committed to excellence in education with high quality pedagogy and dedicated to promoting the all-faceted development of the students.

Gandhinagar University is empowering young minds by imparting quality education, research, and training. Its special emphasis on a multidisciplinary and skill-based approach as outlined in the New Education Policy NEP 2020 sets it apart as a pioneer in the field of higher education. This is University in its correct perspective, integrated ecosystem of education – by offering programmes under one roof. The University achieved many laurels of excellence in its short time of establishment and is striving hard to accomplish many more. The infrastructure of our university is huge, with equipped laboratories with highly qualified, dedicated and committed faculty.

Providing more than ten diverse disciplines and ninety courses of study along with lush green campus, sports pavilion, modern resource center is conducive to continuous learning to become all round competent individual for nation building.

Gandhinagar University - Journal of Engineering and Technology
(Formerly known as GIT- Journal of Engineering and Technology ISSN 2249-6157)

Since 2008, we have successfully published our Engineering and Technology Journal, **formerly known as "GIT - Journal of Engineering and Technology (GIT-JET, ISSN 2249-6157)".** As GIT is now a constituent institute of Gandhinagar University, the title is changed. We are delighted to announce the release of **"Gandhinagar University - Journal of Engineering and Technology".** "Gandhinagar University - Journal of Engineering and Technology GU-JET" is a Peer Reviewed Journal which aims to provide an opportunity to research scholars, faculties, industry experts, working professionals and UG/PG students with faculty guide as a co-author to interact and share their knowledge and experience in the field of Computer Engineering, Information Technology, Mechanical Engineering, Civil Engineering, Electrical Engineering, Electronics and Communication Engineering and Engineering Mathematics. GU-JET's main objective is to motivate potential authors to provide quality research with minimum plagiarism. It includes both fundamental and advanced research-oriented ideas with an expectation that all those who wish to contribute diverse papers such as research articles, review papers.

Engineering & Technology is a field where a lot of research and study is required. **Gandhinagar University - Journal of Engineering and Technology** primarily focuses on providing a platform to the researchers of various engineering streams where a high level of teaching and learning is encouraged. Self-created theories, research; practical/theoretical work, application-based reports/studies are welcomed to add contribution to the better understanding of technical challenges.

Its scope encompasses relevant topics under the broad areas of Computer Engineering, Information Technology, Civil Engineering, Mechanical Engineering, Electronics and Communication Engineering, Electrical Engineering and Engineering Mathematics. Articles of interdisciplinary nature are welcome. The scope of GU-JET is not limited to above mentioned subfields, instead it encourages a broad spectrum of contribution in Engineering & Technology.

GU-JET Editors

Vice Chancellor's Message

In pursuance of the vision of continuing herculean task of nation building, **Gandhinagar University** has been making sincere efforts to promote excellence in education. There is constant endeavor to bring holistic approach through multidisciplinary education.

The perspective of Gandhinagar University is “high quality pedagogy plus choice-based credit system” with continuous performance management of the students to transform them to ‘ready for industry’ in accordance with the New Education Policy (NEP) 2020. Most of the programs of this University cover internship with local industry and businesses with research and innovation focus. The students at this University are determined to accept the challenges globally. In this context, I must state that it is a substantial fact that the Innovation Cell of this University has been rated by Ministry of Education, Government of India at 3.5 out of scale of 4.

This is the University that promote the students all faceted development of wellness- not only physical fitness but also psycho-social well- being with ethical mind-set to achieve specified learning outcomes as all our programs are outcome based. This young Gandhinagar University has been awarded as ‘Prominent University for Futuristic Education’ by Divya Bhaskar this year. We are proud to announce that, we inaugurated the new **AI and blockchain-driven cyber security & digital forensic lab** at Gandhinagar University. This lab signifies a significant step in fortifying digital defenses. This initiative not only escalating cyber threats but also offers students valuable hands-on experience and positions them as adept cyber security professionals. Gandhinagar University commitment to innovation and safeguarding digital landscapes is evident in this forward-looking endeavor. The University achieved many laurels of excellence in its short time of establishment and is striving hard to accomplish many more.

Gandhinagar University is well known for its academic excellence and dedicated approach towards dissemination of knowledge in the academic world. The University appreciates the role of research in

education and is committed to developing an inclination towards research in both faculty and students. Since 2008, we have successfully published our Engineering and Technology Journal, **formerly known as GIT - Journal of Engineering and Technology (GIT-JET, ISSN 2249-6157).** I am delighted to announce the release of **"Gandhinagar University - Journal of Engineering and Technology". "Gandhinagar University - Journal of Engineering and Technology"** is an annual Journal launched exclusively to publish academic research papers and articles by the students/faculties/Researchers on contemporary topics and issues in the wide areas of Engineering and Technology. To maintain high **academic standards, academic ethics and academic integrity**, a rigorous process of blind review of research papers is followed along with screening of plagiarism of each manuscript received for publication. The research work published in GU-JET is original and not published or presented at any other public forum. I congratulate all the students and researchers whose research papers are published in this fifteenth volume of GU-JET and express my sincere thanks to their mentors.

I congratulate the GU-JET committee who have worked determinedly to conceptualize and compile this fifteenth volume of GU-JET publication. I commend the efforts of the Editorial board and Reviewers to bring out the present volume.

I take this opportunity to convey my heartiest feelings of gratitude to our Respected Trustees as they have always been a constant source of motivation and inspiration in all the academic activities. I am sure that the regular publishing of this Journal of Engineering and Technology will comply with the desire of our trustees to excel in the field of Engineering Research.

I am sure more and more contributions would come forth from eminent researchers so that we can bring more laurels in our pursuit of excellence in the area of Engineering and Technology.

Thank you.

Prof. Dr. K. N. Sheth

Vice Chancellor, Gandhinagar University

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Use of Crumb Rubber as partial replacement of bitumen in Bituminous Concrete Mix

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Abstract

The aim of the study was to utilize the waste materials i.e., crumb rubber waste for mass scale utilization such as in highway construction in an environmentally safe manner. As a first part of this study, an attempt was made to assess the stabilization of the bitumen containing crumb rubber waste in shredded form by performing basic tests such as Penetration Test, Ductility Test, Softening Point Test, Viscosity Test and Flash & Fire Point Tests. On the basis of the performance of the modified bitumen, the range of optimum percentages of crumb rubber waste Study on effect of crumb rubber modified binder on bituminous concrete mixes will be decided. The dimension of used CR ranges from 0 to 2.36 mm, which is not too coarse for promoting the CR–bitumen interaction and not too fine for facilitating the production of CR. The content of CR was increased gradually from 3 to 5 to examine the effects of CR content on the engineering properties and determine the optimal content in the mixture. Marshall Test has been considered for the purpose of mix design as well as evaluation of paving mixes. The quantity of optimum binder content was determined by Marshall Stability test for samples. The mechanical performance was determined for Marshall Stability, deformation behaviour or flow, as well as for density and void appearances base on prevailing Indian standards specifications.

Keywords: bituminous concrete, Marshall Properties (flow value, stability), optimum bitumen content, crumb rubber waste.

1. Introduction

Crumb rubber is recycled rubber produced from automobiles and truck scraped tires. During the recycling process of this rubber crumb, steel and tire cord (fluff) are removed, and tire rubber are produced with a granular consistency. India has a road network of over 4,689,842 kilometers in 2013, the second largest road network in the world. It has primarily flexible pavement design which constitutes more than 98% of the total road network. India being a very vast country has widely varying climates, terrains, construction materials and mixed traffic conditions both in terms of loads and volumes. Increased traffic factors such as heavier loads, higher traffic volume and higher tyre pressure demand higher performance pavements. So, to minimize the damage of pavement surface and increase durability of flexible pavement, the conventional bitumen needs to be improved. There are many modification processes and additives that are currently used in bitumen modifications such as styrene butadiene Styrene (SBS), styrene-butadiene rubber (SBR), ethylene vinyl acetate (EVA) and crumb rubber modifier (CRM). Crumb rubber is the term usually applied to recycled rubber from automotive and truck scrap tires. During the recycling process steel and fluff is removed leaving tire rubber with a granular consistency. Continued processing with a granulator and/or cracker mill, possibly with the aid of cryogenics or mechanical means, reduces the size of the particles. From physical and chemical interaction of crumb rubber with conventional bitumen Crumb Rubber Modified Bitumen (CRMB) is made. Its advantages are: Lower susceptibility to daily & seasonal temperature variations, higher resistance to deformation at elevated pavement temperature, better age resistance properties, higher fatigue life of mixes, better adhesion between aggregate & binder, Prevention of cracking & reflective cracking, and overall improved performance in extreme climatic conditions & under heavy traffic condition. Several studies show improved performance of asphalt modified by crumb rubber, resulting in reduced cracking and increased fatigue life, strength, resilience, viscosity and adhesion.

2. Experimental Investigation

The Marshall Stability test was carried out using marshal test and stability flow indicator. The stability (kN), unit weight (gm/cc), percentage of air voids present in the sample, flow value measured in mm, percentage of voids filled with bitumen (VFB) and voids in mineral aggregate (VMA) were evaluated on each sample. Results of all the parameters the sample are mentioned as in table 1 Second point.

Table 1. Parameter Obtained for CRMB mix

Crumb rubber content%	Bitumen Content %	Unit weight (gm/cc)	Air voids %	Voids in Mineral aggregate VMA %	Voids filled by Bitumen VFB %	Stability (KN)	Flow (mm)
3	4.5	2.35	2.89	12.62	77.09	8.884	2.61
	5	2.38	4.8	15.7	69.43	12.984	3.57
	5.5	2.385	3.83	15.8	75.76	11.617	3.84
	6	2.39	2.24	16.26	70.07	9.226	4.03
	6.5	2.40	2.40	16.50	85.45	8.200	4.2
4	4.5	2.28	5.78	15.59	62.92	8.884	2.35
	5	2.305	4.36	15.33	71.56	13.326	3.68
	5.5	2.32	2.93	15.02	80.49	10.592	3.84
	6	2.33	2.10	15.28	86.25	7.859	4.05
	6.5	2.325	1.48	15.66	90.95	7.175	4.10
5	4.5	2.28	4.60	14.32	67.88	9.909	2.65
	5	2.29	3.79	14.59	74.02	14.009	3.75
	5.5	2.295	2.75	14.59	81.15	12.301	3.96
	6	2.30	2.12	15.01	85.88	9.225	4.12
	6.5	2.285	2.14	15.95	86.38	8.542	4.32

Table 2. Marshall Parameter for CRMB at OBC

Sr. No.	Marshall Parameters	Specified Range MORT&H	Obtained values at OBC		
1	Unit Weight	-	3%	4%	5%
2	Air Voids%	3-6	2.38	2.305	2.29
3	VMA	Min. 14	4.8	4.36	3.79
4	VFB	65-75	15.7	15.33	14.59
5	Stability (KN)	Min. 9 KN	69.43	71.59	74.02
6	Flow Value (mm)	2-4	12.984	13.326	14.009

Table 3. Volumetric Properties for Conventional Mix

Sr. No.	% Bitumen Content	Unit weight (gm/cc)	Air voids %	Voids in Mineral aggregate VMA %	Voids filled by Bitumen VFB %	Stability (KN)	Flow (mm)
1	4.5	2.377	6.461	17.627	63.35	7.747	3.1
2	5	2.392	5.598	17.263	67.57	9.386	3.37
3	5.5	2.405	4.622	17.078	72.93	11.142	3.5
4	6	2.393	4.775	17.676	72.98	7.825	4.03
5	6.5	2.367	5.492	18.752	70.71	6.623	4.2

The table:3 shows the summary of volumetric properties of the mix along with stability and flow values of the Conventional Bituminous Concrete Mixes. The maximum stability value is 11.142 KN at 5.5% binder content. The flow values are found between the specified ranges in MORTH for optimum bitumen content is 3.5mm and increases with increase of binder content. Also, at 5.5% Bitumen content mix satisfy entire minimum requirement of MORTH. Estimated OBC for conventional mix is 5.5%.

3. RESULT AND DISCUSSION

The Optimum Binder Content (OBC) for specimens containing 3%, 4% and 5% CRMB was estimated to be 5%. The results of the Marshall Test parameters obtained at OBC value for all the types of samples are shown in Table-7. It was noted that the crumb rubber meets all minimum requirements as per MORTH 2012 Specification m aggregate material in Bituminous Concrete.

A. Unit Weight

For all the samples, the maximum compacted density attained is almost the same (2.42 gm/cc). Moreover, the density increases till its maxima and then decreases for all mixes. 5% CRMB containing mix has higher density than 3% &4% CRMB containing mix at OBC as shown in fig. 1.

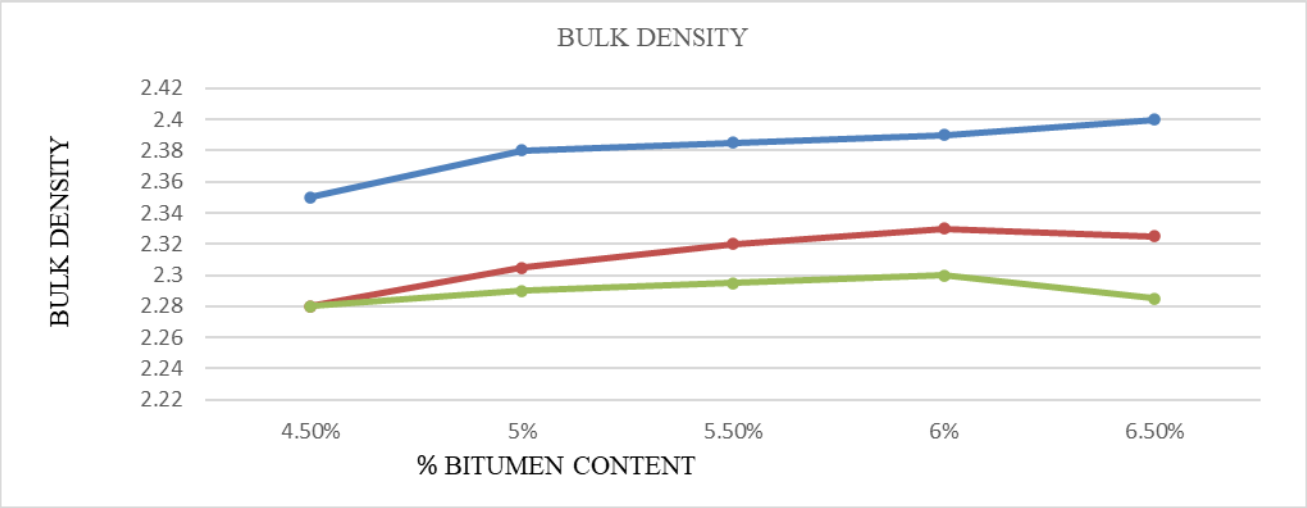

Fig. 1. Graph - % Bitumen Content Vs Bulk Density

B. Air Voids

Table-1 indicates that the percentage of air voids in the mix decreases for all mixes as the bitumen content increases. This is expected since the bitumen will fill the voids in the aggregate matrix. According to MORT&H criteria, voids in the mix must range from 3% to 5%.

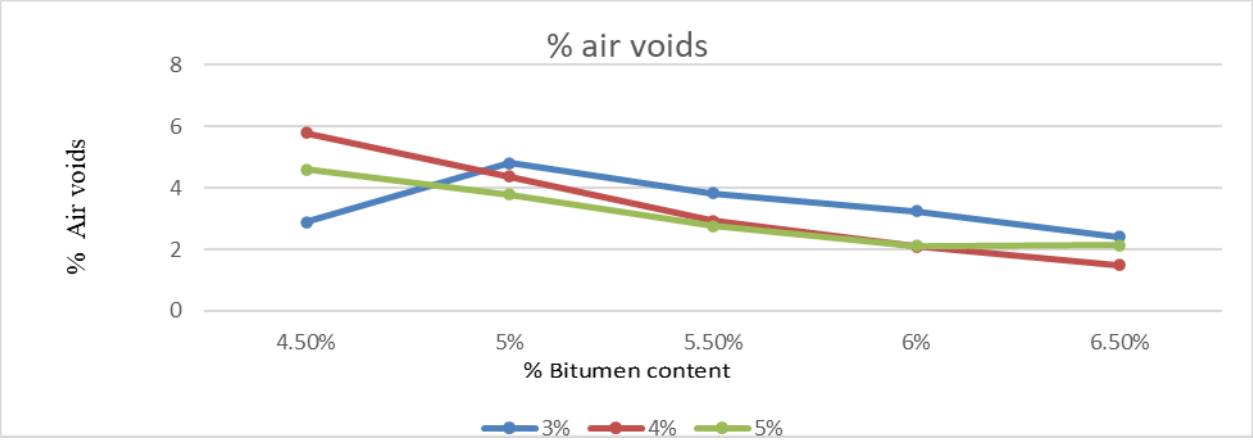

Fig. 2. Graph - % Bitumen Content Vs Air Voids

C. Marshall Stability Value

Marshall Stability values are higher as in case of 5% CRMB containing crumb rubber as compared to 3% and 4% crumb rubber waste containing mix. Fig-3 shows that the stability value increases till the addition of 5% bitumen content in 3%, 4% and 5% CRMB containing mixes respectively and then decreases rapidly.

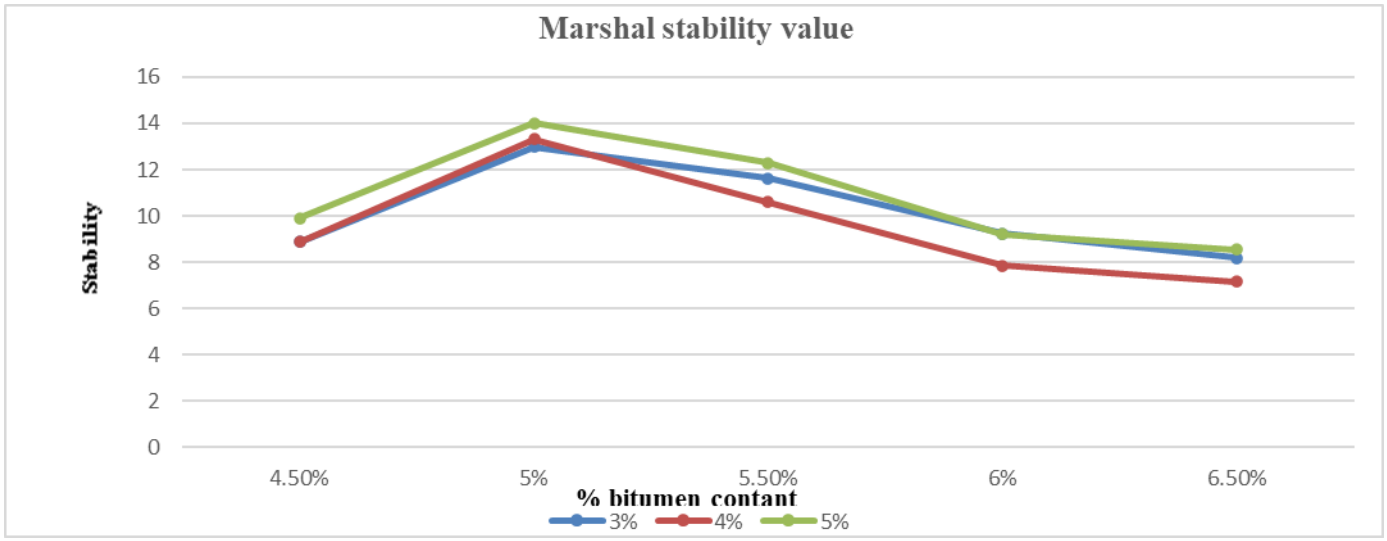

Fig. 3. Graph - % Bitumen Content Vs Stability

D. Flow Values

Flow values for 3%, 4% & 5% CRMB containing mixes are 3.57, 3.68 and 3.75 respectively at OBC (optimum bitumen content). Crumb rubber waste mixes show continuous increase in flow values.
The results obtained shows that crumb rubber waste will deform more under the traffic loads and will have more flexibility. However, 3%, 4% and 5% CRMB as can be used in BC at OBC as shown in Figure 4.

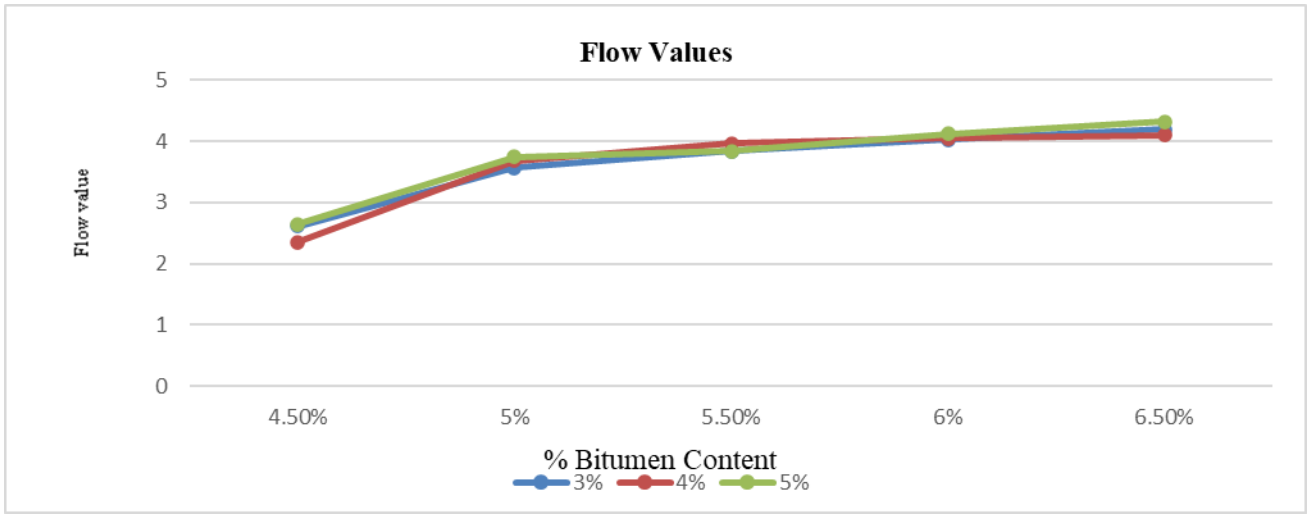

Fig. 4. Graph - % Bitumen Content Vs Flow Value

4. Conclusion

The Marshall tests were conducted on the bituminous mixes containing 3-5% CRMB content. Based on the laboratory experiments and analysis, the following conclusions are drawn.

- It is observed that with the increase in CRMB content from 3% to 5% the stability value increases from 12.984 KN to 14.009 KN at OBC.
- It is observed that conventional mix gives maximum stability about 11.142KN while modified mix gives the maximum stability value about 14.009 KN at OBC.
- Results shows that achieved result for OBC for CRMB Modified mix is 5% and for conventional mixes is 5.5%.
- The flow values for 3 to 5% CRMB mixes are higher than conventional bituminous concrete mixes at OBC which shows that Crumb Rubber containing mix (Modified Mix) will deform more under traffic loads compared to conventional mixes.
- It is observed that 5% Crum Rubber Modified Bituminous Concrete mix gives maximum stability and flow values about to14.009KNand 3.75mm respectively at optimum bitumen content.
- Above result shows that as the amount of Crumb Rubber content increases flow value also increase which indicates that Crumb Rubber containing mixes will deform more under traffic load and gives higher flexibility.
- The patterns obtained in the flow values indicate that Crumb Rubber will deform more under the traffic loads and will have more flexibility.
- The Marshall Properties of CRMB for 3 to 5% Crum Rubber satisfy the limits of MORTH specification and hence can be used in BC as modified binder.
- Crumb Rubber satisfies the entire minimum requirement for modified bituminous concrete mixes as specified in the MORTH.

It was concluded that Crumb Rubber industrial waste can be utilized as a partial replacement for bitumen in bituminous concrete mixes. The utilization of Crumb Rubber in the asphalt concrete mixes may solve the significant disposal problem to save the environment.

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Effect of Crum Rubber Modified Binder on Bituminous Concrete Mix – A Review Paper

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Abstract

The aim of the study was to utilize the waste materials i.e., crumb rubber waste for mass scale utilization such as in highway construction in an environmentally safe manner. As a first part of this study, an attempt was made to assess the stabilization of the bitumen containing crumb rubber waste in shredded form by performing basic tests such as Penetration Test, Ductility Test, Softening Point Test, Viscosity Test and Flash & Fire Point Tests. On the basis of the performance of the modified bitumen, the range of optimum percentages of crumb rubber waste modified binder on bituminous concrete mixes will be decided. The dimension of used CR ranges from 0 to 2.36 mm, which is not too coarse for promoting the CR–bitumen interaction and not too fine for facilitating the production of CR. The content of CR was increased gradually from 3 to 5 to examine the effects of CR content on the engineering properties and determine the optimal content in the mixture.

Keywords: bituminous concrete, Marshall Properties (flow value, stability), optimum bitumen content, crumb rubber waste.

1. Introduction

Crumb rubber is recycled rubber produced from automobiles and truck scraped tires. During the recycling process of this rubber crumb, steel and tire cord (fluff) are removed, and tire rubber are produced with a granular consistency. India has a road network of over 4,689,842 kilometers in 2013, the second largest road network in the world. It has primarily flexible pavement design which constitutes more than 98% of the total road network. India being a very vast country has widely varying climates, terrains, construction materials and mixed traffic conditions both in terms of loads and volumes. Increased traffic factors such as heavier loads, higher traffic volume and higher tyre pressure demand higher performance pavements. So to minimize the damage of pavement surface and increase durability of flexible pavement, the conventional bitumen needs to be improved. There are many modification processes and additives that are currently used in bitumen modifications such as styrene butadiene Styrene (SBS), styrene-butadiene rubber (SBR), ethylene vinyl acetate (EVA) and crumb rubber modifier (CRM). Crumb rubber is the term usually applied to recycled rubber from automotive and truck scrap tires. Several studies show improved performance of asphalt modified by crumb rubber, resulting in reduced cracking and increased fatigue life, strength, resilience, viscosity and adhesion.

2. Objective

- The present study envisages the use of waste material i.e., waste tyres mixed with bitumen, which has potential use in highway and construction industry.
- To determine the density – voids analysis for the given bituminous mixture.
- To determine the strength (Marshall's Stability Value) and flexibility (flow value) for the given bituminous mixture 003B
- To determine the suitability of the bituminous mixture to meet the specified criteria for the surface course.

3. Scope

- The performance study can be carried out where this material is used in the pavement construction.
- Scope for usage of Crumb Rubber material in other bituminous layers like Bituminous Macadam, Semi-Dense Bituminous Macadam and DBM can be explored.
- Statistical analysis also can be carried out for different Crumb Rubber content.

4. Literature of Review

H.T Tai Nguyen, T. Nhan Tran (September 2017)
Effects of crumb rubber content and curing time on the properties of asphalt concrete and stone mastic asphalt using dry process

- In this work, the authors aim to study the effects of crumb rubber (CR) on the mechanical properties, especially the rutting resistance, of CR modified asphalt concrete (AC) and stone mastic asphalt (SMA) by varying two factors-namely, the content of additive and the curing time.
- It was observed that the optimal content is 1.5–2%, while the optimal curing time that contributes to the maximal increase in the mechanical characteristics of both mixtures could not be determined.

Material Physical Properties

Table 1. Specific Gravity of Aggregates

Size of Material	Specific Gravity	Water Absorption %
10mm	2.82	0.76
6mm (natural)	2.79	0.75
Stone Dust	2.64	0.825
Crumb rubber	1.01	

Table 2. Physical Properties of Aggregate

Sr. No.	Description of Test	Test Method	Test Result Observed	Specification as per MORT&H Table-500-18
1	Aggregate Impactvalue (%)	IS-2386 (P-IV)	9.69%	Max 24%
2	Aggregate Crushing value (%)	IS-2386 (P-IV)	15.7%	Max 10-25
3	Los Angle Abrasion value (%)	IS-2386 (P-IV)	17.5%	Max 30%
4	Flakiness and elongation Index (%)	IS-2386 (P-I)	23.53%	Max 30%
5	Water absorption (%)	IS-2386 (P-III)	0.76%	Max 2%
6	Stripping (%)	IS-6241-1971	99.5%	Minimum retained coating 95%

Crumb Rubber Waste

Crumb rubber waste is used in present investigation as additive in bitumen. The physical properties of bitumen and modified bitumen (Containing Crumb rubber) are given in Table.

Table 3. Physical Properties of Bitumen

Sr. No.	Description of test	Test Method Standards	Test Results	Spec. Limit as per MORT&H
1	Specific Gravity	IS:1202	1.001	0.99 Min.
2	Penetration	IS:1203	55	50-70mm
3	Ductility	IS:1208	95	Min. 40cm
4	Softening Point	IS:1205	49.5	Min.47°c
5	Absolute Viscosity	IS:1206	2855	2400 poise
6	Kinematic Viscosity	IS:1206	380	Min-350 cst

Table 4. Physical Properties of CRMB 3% Crumb Rubber

Sr. No.	Description of test	Test Method Standards	Test Results	Spec. Limit as per MORT&H
1	Specific Gravity	IS:1202	1.01	0.99 Min.
2	Penetration	IS:1203	52	50-70mm
3	Ductility	IS:1208	89	Min. 40cm
4	Softening Point	IS:1205	48	Min.47°c
5	Absolute Viscosity	IS:1206	3000	2400 poise
6	Kinematic Viscosity	IS:1206	395	Min-350 cst

Table 5. Physical Properties of CRMB 4% Crumb Rubber

Sr. No.	Description of test	Test Method Standards	Test Results	Spec. Limit as per MORT&H
1	Specific Gravity	IS:1202	1.01	0.99 Min.
2	Penetration	IS:1203	50.5	50-70mm
3	Ductility	IS:1208	87	Min. 40cm
4	Softening Point	IS:1205	47.5	Min.47°c
5	Absolute Viscosity	IS:1206	3050	2400 poise
6	Kinematic Viscosity	IS:1206	395	Min-350 cst

Table 6. Physical Properties of CRMB 5% Crumb Rubber

Sr. No.	Description of test	Test Method Standards	Test Results	Spec. Limit as per MORT&H
1	Specific Gravity	IS:1202	1.01	0.99 Min.
2	Penetration	IS:1203	50	50-70°
3	Ductility	IS:1208	85	Min. 40cm
4	Softening Point	IS:1205	46	Min.47°c
5	Absolute Viscosity	IS:1206	3100	2400 poise
6	Kinematic Viscosity	IS:1206	400	Min-350 cst

Table 7. Gradation Of Aggregates for BC

Sieve size (mm)	Percentage passing	Achieved Result
19	100	100
13.2	79-100	100
9.5	70-88	85.94
4.75	53-71	61.59
2.36	42-58	49.76
1.18	34-48	39.59
0.6	26-38	30.87
0.3	18-28	22.16
0.15	12-20	14.81
0.075	4-10	4.69

5. Conclusion

- The Physical properties of modified bitumen and aggregate were identified. Based on the test result obtained following conclusions are drawn.
- It was observed that with increase of crum rubber from 3 to 5% softening point of bitumen decreases from 52 to 460C.
- With increase of crum rubber from 3 to 5% ductility of modified bitumen gets decreases.

- Stripping value test also have been performed, Result obtained from test represents that modified bitumen provide sufficient coating over the natural aggregate and satisfy minimum criteria for MORTH specification.
- Test result obtained for all the different proportion of modified mixes satisfy the minimum criteria of IS code specification.
- From Physical parameter of modified mixes, it can be concluded that crum rubber can be utilize as partial replacement of bitumen. The patterns obtained in the flow values indicate that Crumb Rubber will deform more under the traffic loads and will have more flexibility.
- It was concluded that Crumb Rubber industrial waste can be utilized as a partial replacement for bitumen in bituminous concrete mixes. The utilization of Crumb Rubber in the asphalt concrete mixes may solve the significant disposal problem to save the environment.

References

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Exploring Machine Learning Techniques for Diabetes Prediction in Healthcare

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Abstract

Diabetes is a chronic illness affecting millions of people worldwide and has the potential to cause a global healthcare crisis. It is a long-term health condition and is characterised by high blood glucose levels, resulting in symptoms such as frequent urination, blurry vision, increased thirst, and increased hunger. Diabetes harms major organs such as the eyes, kidneys, heart, and brain. Detecting diabetes early on can significantly reduce the risk of developing this serious health condition. Machine learning is a scientific field that teaches machines to learn from their experiences. This work intends to create a system for predicting early diabetes by comparing the results of various techniques for machine learning like K-Nearest Neighbor (KNN), Logistic Regression, Decision Tree, and Support Vector Machine (SVM). We utilised two datasets for our machine learning classification tasks: the PIMA Indian diabetes dataset, which is publicly available as an open-source dataset, and a 130-US Hospitals dataset. Further, the combined dataset is employed for each algorithm, and the performance of these algorithms is evaluated on various factors like sensitivity, accuracy, recall, f-measure, and specificity. The number of accurately and inaccurately identified samples is used to estimate accuracy. Based on the evaluation results, the algorithm with the highest performance measure is selected for predicting diabetes.

Keywords: Diabetes, Decision tree, KNN, Logistic Regression, SVM, Accuracy

1. Introduction

1.1. Diabetes Mellitus

Diabetes mellitus is often known as diabetes. Diabetes is a chronic condition that causes problems in the body when the pancreas does not generate enough insulin, which leads to poor carbohydrate metabolism and elevated blood glucose levels. Even among youngsters, diabetes is a major health concern. It is one of the world's worst illnesses. Diabetes can also lead to other illnesses, including heart attacks, renal problems, blindness, etc. Diabetic mellitus is classified as a non-communicable disease (NCD). According to the 2017 statistics, around 426 million people worldwide suffered from diabetes. Approximately 2.5–3.5 million people died due to diabetes. Doctors and researchers claimed that by 2045, this number would rise to 630 million. Four out of every ten people have diabetes, and two in eight have prediabetes. Early diagnosis and treatment can help manage diabetes and stop complications, which can ultimately save lives. Diabetes can be classified into the following types:

- **Type-1 diabetes:** Type-1 diabetes is caused by a deficiency of insulin, as the pancreas is unable to produce sufficient insulin due to the destruction of beta cells by the immune system. This results in elevated blood sugar levels, as the glucose cannot be utilised by the cells without adequate insulin. While the actual reason is unknown, genetic factors are considered to play a key impact. Type-1 diabetes typically affects children and young adults, with 5% to 10% of people being affected. If left untreated then it can lead to severe issues. Management of type-1 diabetes requires regular insulin injections, which vary in type and dosage depending on individual requirements, to control blood sugar levels.

- **Type-2 diabetes:** Type-2 diabetes is a prevalent condition where the body produces enough insulin, but cells do not use it efficiently, resulting in increased blood glucose levels. Our pancreas may produce less insulin over time. This form of diabetes accounts for around 90% of all cases and is commonly observed in both young and elderly individuals. Type-2 diabetes poses a high risk of developing several medical complications, such as diabetic retinopathy (which damages blood vessels in the eyes), diabetic neuropathy, and kidney and cardiovascular diseases. This is an ongoing disease with no known cure yet. Patients are advised to make certain lifestyle modifications to maintain normal blood glucose levels.

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- **Gestational diabetes:** Other than in women who already have diabetes, gestational diabetes is a type of diabetes that arises in pregnancy. This type of diabetes is similar to type 2 diabetes and is more likely to develop in obese women. While gestational diabetes is reversible and typically resolves after childbirth, it can lead to perinatal complications and pose health risks for both the mother and newborn.

1.2. Machine Learning in Diabetes Prediction

The use of machine learning applications in healthcare is beneficial for clinicians and patients as it enables better decision making in less time and at lower costs. These applications aim to provide high-quality services that are affordable for patients. While healthcare systems are complex, emerging techniques have made evaluation easier than before. Various algorithms are being combined to improve the accuracy of experiments. Early predictive analysis is essential for determining the severity of a disease. Machine learning algorithms are used as a hybrid model approach to compare and analyse patterns and accuracy using various tools for decision making in the medical field. Three main types of machine learning algorithms are:

- **Supervised learning**: In supervised learning, the system is trained on a set of input-output pairs, known as training data, to learn a function that can accurately predict the output value for new, unseen inputs. The goal of supervised learning is to find a target function that minimises the error between the predicted output and the actual output. The input variables, or independent variables, are also known as features or attributes, and the output variable, or dependent variable, is the target variable. The domain of the target function is the set of all possible input values or instances. Classification and regression are the two main kinds of algorithms used in supervised learning. The target variable in classification is categorical data, and the purpose is to predict the class or category of a new input instance. In regression, the target variable is a continuous variable, and the goal is to predict a numerical value for a new input instance.

- **Unsupervised learning**: Unsupervised learning is a technique that is used to identify hidden patterns and structures within a dataset whose input is known but whose output is unknown. It is commonly used on transactional data, where clustering algorithms like k-means and hierarchical clustering are used to identify similar groups of data. However, noisy and missing data can make the extraction of meaningful information from a dataset difficult. Data mining plays an important role in unsupervised learning because it helps identify patterns and relationships among variables in large sets of data. There are two different types of methods in unsupervised learning: the method that is used to group the objects into clusters with the most similarities is known as clustering, and the method that is used to find relationships between variables is known as an association.

- **Reinforcement Learning**: Reinforcement learning is a broad term that refers to a class of machine learning techniques in which a model learns by interacting with its environment to optimise a reward function. Unlike other types of machine learning, this system has no advanced knowledge of the environment's behaviour and must learn through trial and error. Throughout this trial-and-error phase, the system takes action and receives feedback in the form of a reward signal. Reinforcement learning is especially beneficial for creating autonomous systems that can learn from and adapt to new surroundings without explicit programming or oversight. Because of its independence from the environment, reinforcement learning is appealing for a wide range of applications, including decision-making, gameplay, and robotics.

2. Literature Review

In this related work section, we are briefly going to discuss the earlier work done by researchers in this field of diabetes mellitus prediction using machine learning. One such study by N. Fazakis et al. [1] proposed an IoT-enabled framework for workers which monitors users' health, well-being, and functional ability in an unobtrusive manner. The framework was empowered with AI tools and applied various machine learning algorithms, including ensemble learning, to predict the occurrence of Type 2 Diabetes Mellitus (T2DM). The author in this work used the English Longitudinal Study of Ageing (ELSA) database, and different features of models trained on this dataset are compared; mainly the AUC curve was used to compare the performance of different algorithms.In the realm of machine learning, KM Jyoti Rani [2] conducted an analysis of a dataset obtained from the UCI machine learning repositories. The author aimed to improve the accuracy of the dataset by utilising five different techniques, including Support Vector Machine (SVM), Random Forest, Decision Tree, K Nearest Neighbor (KNN), and Logistic Regression. After conducting the analysis, the proposed method found that the Decision Tree classifier outperformed the other techniques, achieving a 98% accuracy rate on the training dataset. Deepti Sisodia et al. [3] evaluated three different classifiers on the PIDD (Pima Indian Diabetes Dataset): SVM, Naive Bayes, and Decision Tree. The author analysed the techniques in this work using multiple measures, and the results were validated using the Receiver Characteristic (ROC) curve. The obtained results show that Naive Bayes beats all other algorithms in terms of accuracy, with 76.30% accuracy. In [5], Mujumdar, Aishwarya, and Vaidehi V. use a pipeline approach to try to enhance the classifier's performance utilising a new dataset instead of an old dataset in [5]. The model was separated into five parts, including Dataset Collecting, Data Pre-processing, Clustering, Build Model, and Evaluation. AdaBoost classifier was found to be the best model using the pipeline, with an accuracy of 98.8%. Mitushi Soni et al. [4] presented their work on early diabetes mellitus (DM) prediction utilising six different classifiers. The author applied feature subset selection approaches, which aid in the elimination of

irrelevant features. The feature importance plot indicates that skin thickness is less significant in the case of a random forest classifier, and the results demonstrate that random forest outperforms others with 77% accuracy in comparison.

3. Proposed Methodology

This section discusses the techniques and methods used to build the proposed diabetes prediction system. In this section, we will discover the several classifiers that machine learning uses to predict diabetes. We will also discuss our proposed techniques for improving accuracy. The methodology begins by collecting the dataset required for the study. The dataset used in this research was obtained from the UCI machine learning repository. Once the dataset is obtained, it is merged to form a comprehensive and unified dataset that incorporates all the necessary variables and information. This merged dataset serves as the foundation for further analysis and model development. Next, data preprocessing techniques are applied to the merged dataset to handle missing values and outliers and ensure data quality. This includes checking for missing values and transforming instances of diabetes into numerical values (e.g., 1 or 0). Feature selection is performed to identify the most relevant features for diabetes prediction, reducing the dimensionality of the dataset. After preprocessing, the dataset is split into two subsets: the training data and the test data. The training data, which constitutes 80% of the dataset, is used to train various machine learning algorithms, including K-Nearest Neighbor (KNN), Support Vector Machine (SVM), Decision Tree (DT), and Logistic Regression (LR). Each algorithm is built and trained based on the training set. Subsequently, the trained classifier models are tested using the remaining 20% of the data, referred to as the test set, to evaluate their predictive performance. The performance evaluation includes measuring accuracy, precision, recall, and F1-score, among other evaluation measures. Through comparison and evaluation of the experimental results obtained for each classifier, the best-performing algorithm for diabetes prediction is determined. The overall process, including data collection, dataset merging, data preprocessing, data splitting, algorithm selection, model building, and model evaluation, is summarised in Figure 1 below. This methodology provides a systematic approach to developing and evaluating predictive models for diabetes using machine learning algorithms.

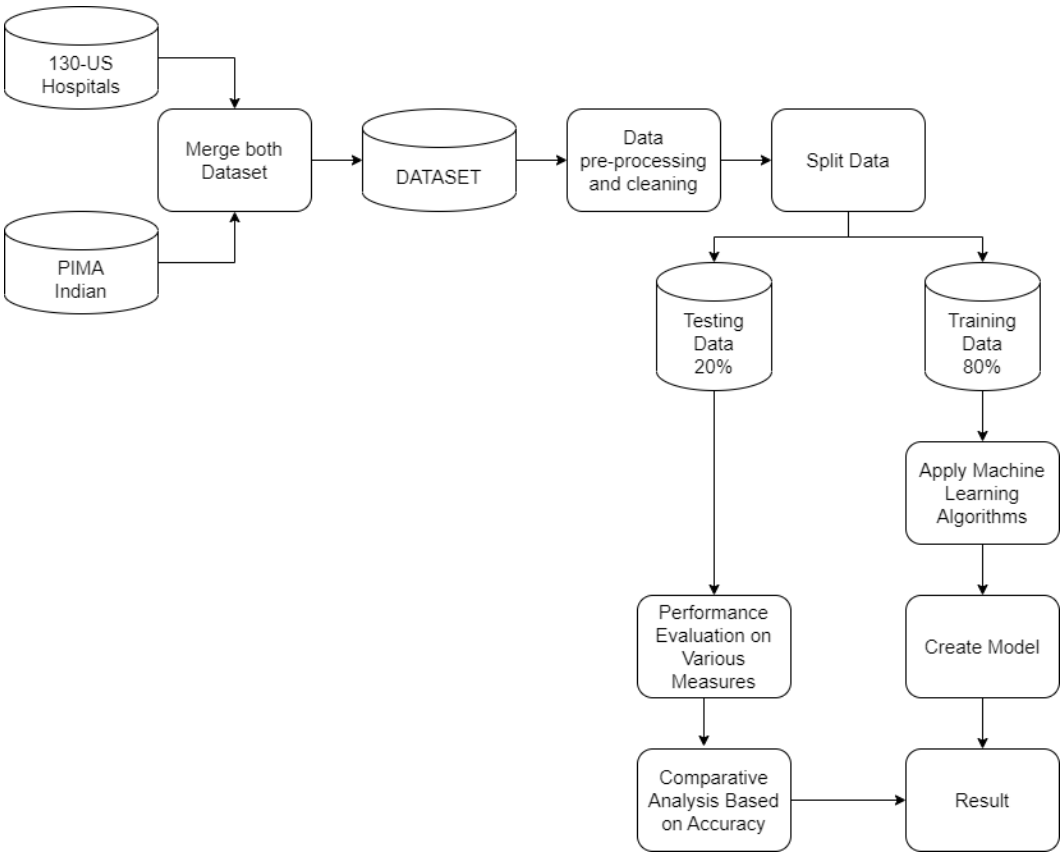

Fig. 1. Working Sequences of a Machine Learning-based Diabetes Prediction Model

3.1 Dataset Description

This study has made use of the publicly available Pima Indian Diabetes Dataset, which includes records on 768 female patients aged 21 and older as well as a parameter that shows the presence or absence of diabetes. The dataset, however, is slightly biassed, with around 500 cases labelled negative (0) and 268 instances labelled positive (1) for diabetes. The attributes of the dataset are illustrated in table 1. In addition to this dataset, the articles provided a dataset of 130 US hospitals that has been prepared to analyse outcomes pertaining to patients with diabetes. Both datasets were pooled to train a diabetes prediction model, yielding a total of 6768 characteristics.

Table 1. Dataset Attribute Description

No.	Attribute	Description
1	Pregnancies	No. of times pregnant
2	Glucose (mg/dL)	Plasma glucose concentration
3	BloodPressure ($mm\ Hg$)	Diastolic blood pressure
4	SkinThickness (mm)	Skin fold thickness
5	Insulin ($\mu U/ml$)	2 hours serum insulin
6	BMI (kg/m^2)	Body mass index
7	DiabetesPedigreeFunction	Diabetes pedigree function
8	Age ($years$)	Age in years
9	Outcome	class ‘0’ - non-diabetic, class ‘1’- Diabetic

Table 2. Dataset Description

Dataset	No. of Instances	No. of Attributes
PIMA	768	9
130-US Hospital	6000	9
Total	6768	9

3.2 Pre-processing

In the situation of a medical dataset, where missing values are common, data preparation is crucial. The accuracy of predictions made from the dataset may be compromised due to missing values or inconsistent data. Data preprocessing techniques are used to overcome this issue. Because some variables, such as BMI and skin thickness, cannot have zero values, the mean value of their corresponding attributes is derived from the dataset and used to replace missing values. In the case of merged diabetes datasets, two preprocessing steps are carried out. The first step involves removing all instances with a zero value, as such values are not possible and are likely due to data entry errors. The second step is data splitting, where the cleaned data is normalised and separated into training and testing sets. This is done using the holdout validation technique, where 80% of the data is used for training and 20% for testing. The training process generates a model based on logic and algorithms using the feature values in the training data, while the test dataset is used to validate the accuracy of the model. By following these preprocessing steps, we can ensure that the machine learning techniques applied to the dataset produce accurate and reliable results.

3.3 Classification Algorithms and Techniques

3.3.1 K Nearest Neighbors

K-nearest neighbor (KNN) is a versatile and widely used machine learning algorithm renowned for its simplicity and effectiveness in classification and regression tasks. With its intuitive approach, KNN finds its strength in identifying the closest neighbours to a

given data point and utilising their characteristics to make predictions. By employing distance metrics such as Euclidean or Manhattan distance, KNN measures the proximity between the input data point and every other data point in the training set. The k nearest neighbors, determined by their distances, are then chosen to contribute to the prediction process. For classification tasks, KNN assigns the majority class among the nearest neighbours as the predicted label for the input data point. In regression tasks, the predicted value is often determined by calculating the mean or median of the target values of the nearest neighbours. The choice of k, the distance metric, and appropriate data normalisation techniques greatly influence the algorithm's results.

3.3.2 Decision Tree

Decision trees are widely employed supervised machine learning algorithms capable of handling classification and regression tasks. They operate by constructing a hierarchical structure composed of nodes that make decisions based on features or attributes. At each node, the algorithm carefully selects the feature that yields the highest information gain, allowing for the division of data into distinct classes. This process continues recursively, as the decision tree grows by choosing the most suitable attribute to separate the data at each subsequent node. The ultimate goal is to accurately classify all the data points by correctly assigning them to their respective classes.

3.3.3 Support Vector Machine

A popular supervised machine learning approach for classification and regression analysis is the Support Vector Machine (SVM). Its primary goal is to group the points in the provided dataset into clearly defined groups. Support vectors are well selected hyperplanes that maximise the margin or distance between the closest data points of various classifications. SVM seeks to improve generalisation and increase its capacity to correctly categorise unobserved cases in both the training and test sets by optimising this margin. The chosen hyperplane, often referred to as the Optimal Separating Hyperplane, reduces the chance of misclassifying training instances while also ensuring robustness when processing brand-new, untested data points.

3.3.4 Logistic Regression

The supervised learning classification process known as logistic regression is frequently used to calculate the likelihood of a binary response based on one or more predictors. These predictors may be continuous or discrete in type. Its main goal is to categorise or separate data objects into separate categories. When dealing with binary classification jobs, like evaluating whether a patient is positive or negative for a certain medical condition like diabetes, this technique is quite helpful. Finding the best-fitting model that explains the relationship between the target variable and the predictor variables is the goal of logistic regression. It uses the sigmoid function, which is based on the theory of linear regression. It always gives the probability for a particular data set between 0 and 1, and, according to the probability, we put the instance in a particular class.

3.4 Evaluation

It is important to provide various measures to discuss the pros and cons of classification models and evaluate their performance. A variety of measures are used to assess the performance of machine learning models. Accuracy, confusion matrix, precision, recall, F1 score, and specificity are among these measurements. The confusion matrix, which is clearly depicted below in Table 3, makes it simple to determine how the built predictive model performs. It outputs a matrix that summarises the overall performance of the model. The confusion matrix is a helpful tool for evaluating classification model performance, providing a summary of predicted and observed classes. Based on whether the expected and actual values match, this matrix divides predictions into four individual instances: True Positive (TP), False Negative (FN), True Negative (TN), and False Positive (FP). True positive, true negative, false positive, and false negative are used to determine other metrics such as sensitivity, specificity, accuracy, precision, and F1 score.

Table 3. Confusion matrix

Actual class	Positive	Negative
Positive	True Positive (TP)	False Positive (FP)
Negative	False Negative (FN)	True Negative (TN)

Accuracy: Accuracy represents the percentage of right predictions out of the total number of predictions. Mathematically, it is given as

$$Accuracy = (TP + TN)/(TP + FN + FP + TN) \quad (1)$$

Specificity: The proportion of participants who are correctly classified as negative is referred to as specificity. This can be expressed in terms of a mathematical equation as

$$Specificity = TN/(TN + FP) \quad (2)$$

Recall/Sensitivity: The proportion of participants who are correctly classified as positive is referred to as sensitivity. It is expressed as

$$Recall = TP/(TP + FN) \quad (3)$$

Precision: Precision is calculated by dividing the number of correct positive outcomes by the number of positive results predicted by the classifier. This can be defined mathematically as

$$Precision = TP/(TP + FP) \quad (4)$$

F1-Score: The F1 score is the harmonic mean of precision and recall, and it measures the test's correctness. It is presented in mathematical terms like

$$F1\ Score = 2 * (precision * recall)/(precision + recall) \quad (5)$$

4. Experimental Results

As can be seen from the below plot, the testing data showed that KNN had an accuracy of 82.67%, the decision tree had an accuracy of 76.17%, logistic regression had an accuracy of 78.88%, and SVM had an accuracy of 76.35%.

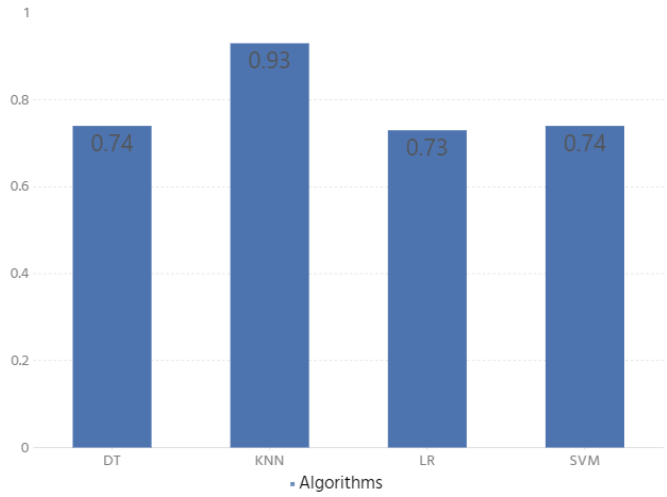

Fig. 2. Machine Learning Algorithm Accuracy Comparison Bar Graph

Based on these findings, it is possible to infer that KNN outperformed all other algorithms in terms of accuracy, while the decision tree had the lowest accuracy. For these algorithms, quality metrics such as accuracy, recall, precision, F1 Score, and specificity were computed and shown in Table 4. Figures 3–6 show the confusion matrix of prediction using support vector machines, k-nearest neighbors, decision tree, and logistic regression, with LR displaying the largest number of true positives and KNN displaying the highest number of true negatives. Additionally, KNN had the fewest false negatives, whereas LR had the fewest false positives. The introduction of a new dataset has improved the accuracy of KNN but has not impacted decision tree, SVM, or logistic regression. KNN achieved an accuracy rate of 93.04% on the testing dataset when K = 11 and input data were used. These findings provide valuable insights into the performance of different classification algorithms and can assist in selecting the most suitable algorithm

for a specific application. It can be concluded that KNN is superior to decision tree, SVM, and logistic regression in predicting whether a person is diabetic or not, with "1" representing positive results and "0" representing negative results.

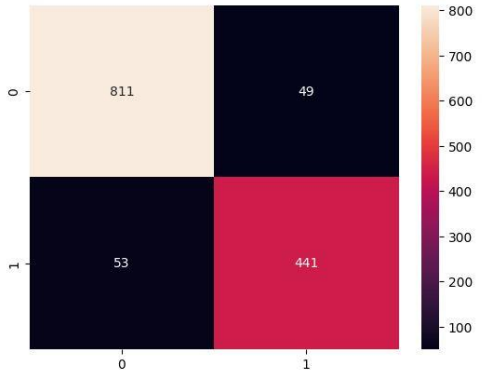

Fig. 3. KNN Confusion matrix

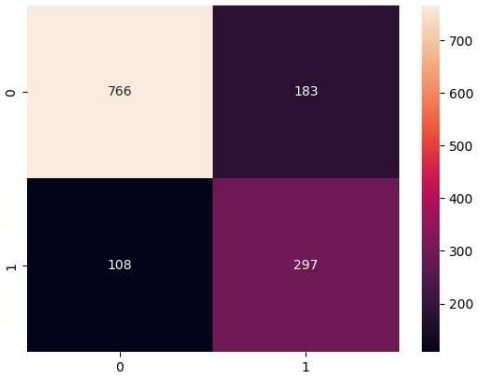

Fig. 4. DT Confusion matrix

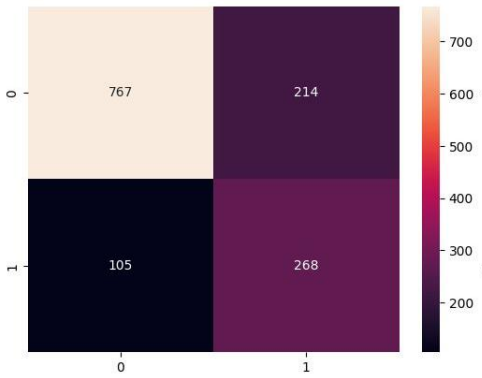

Fig. 5. LR Confusion matrix

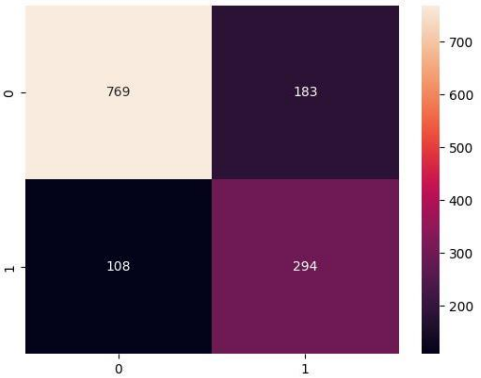

Fig. 6. SVM Confusion matrix

Table 4. Performance measure of classifier in the merged dataset (RTML and PIMA Indian)

Classifier	Recall	Precision	Specificity	Accuracy %	F1 Score
Decision Tree	0.87	0.80	0.61	74.86	0.84
K-Nearest Neighbor	0.93	0.94	0.90	93.04	0.94
Logistic Regression	0.87	0.78	0.55	73.67	0.82
Support Vector Machine	0.87	0.80	0.61	74.79	0.84

5. Conclusion

One of the most important real-world medical problems is the detection of diabetes at an early stage. Experimental results can be used to improve health care intake through early predictions and making early decisions to cure diabetes and save human lives. In this paper, our main aim was to design and implement diabetes prediction using machine learning techniques and do a comparative performance analysis of the models trained using those techniques, which has been achieved successfully. The proposed approach uses four machine learning classification techniques: SVM, KNN, Decision Tree, and Logistic Regression classifiers. The effectiveness of these classifiers is examined by conducting experiments on an open-source Pima Indian dataset and a 130-US

hospitals dataset. The performance metrics, namely specificity, sensitivity, accuracy, recall, and f-measure, are computed for the given machine learning and ensemble techniques. We found that the KNN classifier has the highest accuracy through the confusion matrix evaluation test, with 93.04% classification accuracy and an F1 score and precision of 0.94 and 0.94, respectively. It is observed that the model's accuracy improves with this dataset compared to the existing one. In the future, it is planned to improve the accuracy of the prediction by testing our classification techniques on the huge dataset, and its performance can be improved. Some future scopes of this work include deploying the best performing KNN classifier into a website and smartphone application to predict diabetes instantly. We can achieve better results by collecting more data from a larger group of patients.

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A Review on Fabrication and Characterization of Aluminum based Metal Matrix Composites using Stir Casting

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Abstract

The need to reduce energy consumption and pollution in an industry is currently the most crucial demand of an industry, and necessity is the mother of research (invention). One method for achieving this would be to improve efficiency. It is necessary to enhance the material's characteristics, such as strength, toughness, stiffness to weight ratio, good formability, good corrosion resistance, and high mach inability. The structural, aerospace, and automotive industries all extensively use these composite materials. MMCs are made of a metallic base material called matrix that has been strengthened with either soft or hard ceramic reinforcement. By adding multiple types of reinforcements with various properties to the matrix alloy, hybrid MMCs are created. For instance, SiC and graphite could be used as hard and soft ceramic reinforcement, respectively. The review of the fabrication and characterization of a hybrid metal matrix, as well as a summary of recent advancements relating to the use of aluminium in the manufacturing process, are the main topics of this research paper.

Keywords: Metal matrix composite, Stir casting method, Hybrid metal matrix composite, SiC, Surface roughness

1. Introduction

If a composite material is a substance made up of two or more constituent materials. It is also referred to as a composition material or, more commonly, just as composite. These constituent materials are combined to create a material with characteristics distinct from the constituent parts, despite having distinctly different chemical or physical properties. Composites are distinct from mixtures and solid solutions because the individual components are distinct and remain separate within the final structure.

Composites are significant materials that are now widely used in many fields of commercial mechanical engineering, including but not limited to the aerospace industry. Applications include internal combustion engines, machine parts, thermal management, and electronic packaging, as well as the structural elements of cars, trains, and planes, as well as mechanical parts like brakes, drive shafts, flywheels, tanks, and pressure vessels, as well as biomedical equipment.

For engineering applications, it is necessary to use materials that are stronger, lighter, and more readily available. The materials must have low density, high strength, good toughness, low cost, and good chemical resistance.

1.1. Metal Matrix Composite (MMCs)

The superior qualities of metal matrix composites (MMCs) compared to most conventional materials are currently the subject of research. The scientific community has done a lot of research on two types of reinforcement: alumina and silicon carbide. In order to improve the final behaviour of AMCs and to avoid some disadvantages of utilising ceramics as reinforcement for aluminium alloys, the introduction of new reinforcements such intermetallics to aluminium alloys is still being studied. The two main barriers to the use of such materials at the moment are their high cost and chemical reactions at reinforcement/matrix interfaces during material production and service at high temperatures.

Metal matrix composites are usually made up of aluminum to give it enough strength as it is less dense than iron, and hence is preferred in the aerospace industry. Continuous carbon, silicon carbide, or ceramic fibres are embedded in a metallic matrix to create this substance.

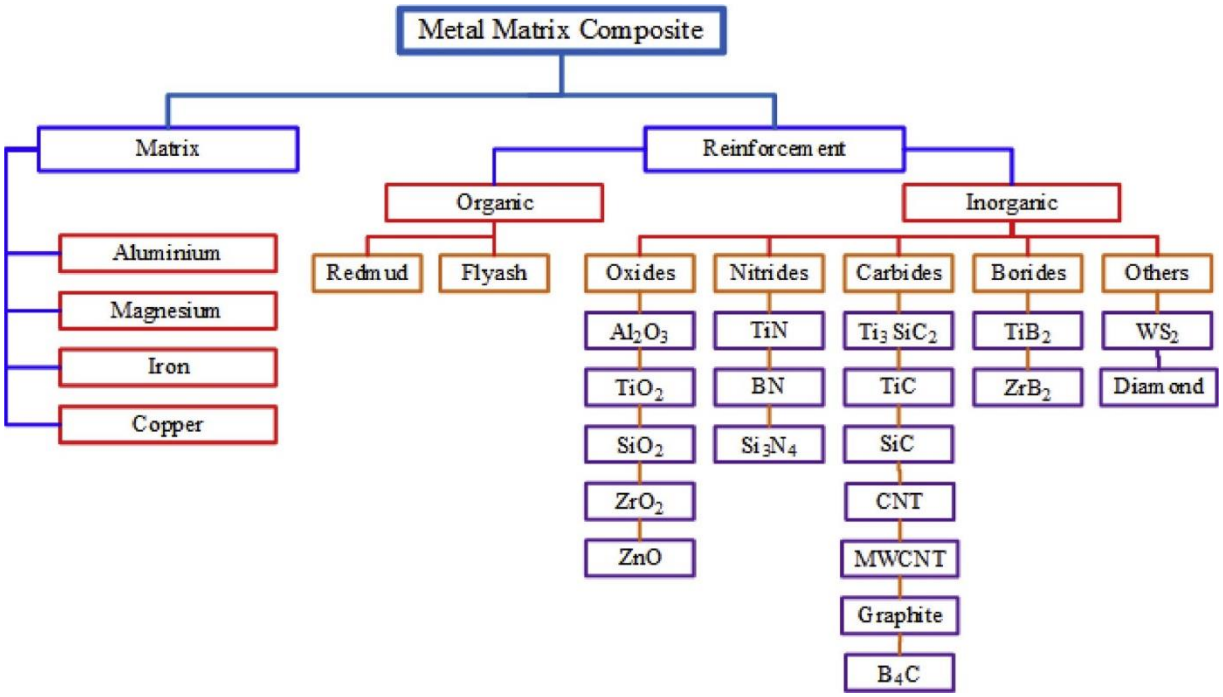


Fig. 1. Various matrix and reinforcement materials used for the production of MMCs. [29]

Aluminum matrix composites are the most prevalent type of metal matrix composites. Major benefits of aluminium matrix composites include higher wear resistance, lower density, and strong corrosion resistance in addition to increased specific strength, specific stiffness, and elevated temperature strength.

The reinforcements may take the form of particles, fibre, layers, or even interpenetrating materials. Composites can be divided into fibre reinforced, laminar, flake, filled, and particle reinforced composites depending on the type of reinforcement utilised. Because they are more widely available, less expensive, and easier to spread in the matrix, particle reinforced composites are the main focus of this review. Based on the goals and applications of the composite, reinforcement materials are chosen. Applications where weight reduction is a top goal are now possible thanks to the strengthening of light metals. One of the most popular MMCs, Al reinforced with SiC, Al2O3, or B4C, produces better mechanical qualities at comparatively cheaper production costs.In the process of creating composite materials, interfacial bonding is a major source of worry. It is challenging to obtain the desired qualities from the constructed composites if the matrix and reinforcement components are not properly matched. The several matrix and reinforcing materials that can be employed to create MMCs are depicted in Fig. 2.

1.1.1. MMCs Applications

- Composite materials are frequently used in the aerospace sector to build the structures of both military and commercial aircraft and spacecraft.
- Composites offer notable advancements in corrosion response and structural response.
- Building of structures like the Kodak pavilion for an exhibition, bridges, lighthouses, hydraulic structures, storage tanks, and door and window parts.
- Stabilization of damaged structures.
- Production of fishing boats, yachts, and life boats.

Fig. 2. Short fiber particulate reinforced aluminum matrix composite used as a cylinder liner in the Honda Prelude. [27]

2. Processing of Metal Matrix Composites

2.1. Processing of Metal Matrix Composites in Stir casting

Stir casting of metal matrix composites was invented in 1968 by S. Ray, who mixed molten aluminium alloys containing ceramic powders to introduce alumina particles into the melt. An illustration shows a schematic of the setup for the stir casting technique used to prepare composites. In a stir casting method, mechanical stirring is used to disperse the reinforcing phases, which are typically in powder form, throughout the molten aluminium. A crucial component of this procedure is mechanical stirring in the furnace. The molten alloy that is produced with ceramic particles can subsequently be utilised for sand casting, die casting, or permanent mould casting. [30]

The capacity of this two-step processing technique to dissolve the gas layer surrounding the particle surface is primarily responsible for its success. The thin layer of gas that is typically absorbed on the surface of particles prevents wetting between the particles and the molten metal. Because the high melt viscosity generates a more abrasive action on the particle surface than traditional stirring does, mixing the particles while they are semi-solid allows for a more effective breakdown of the gas layer. As a result, the subsequent mixing in a totally liquid condition is more successful after the gas layer is broken. Using a suitable stirring system, such as mechanical, ultrasonic, electromagnetic, or centrifugal force stirring, along with typical metal processing techniques is possible with stir casting. Stir casting's potential to be used in large-scale production is one of its main benefits. Stir casting is the most affordable way of creating established metal matrix composites. Stir casting is currently the most widely used commercial process for making aluminum-based composites as a result. [30]

The setup for the Stir Casting Method is show in fig. 3. In stir casting, the molten metal matrix is stirred using a stirrer. The material used to make the stirrer typically has a higher melting point than the matrix temperature. Graphite stirrers are typically used in stir casting. The stirrer primarily consists of two components: a cylindrical rod and an impeller. The rod's other end is attached to the motor shaft, and its other end is connected to the impeller. The stirrer is typically kept vertical and rotates at different speeds thanks to a motor. Afterward, the molten metal is poured into a die for casting. Stir casting can be used to create composites with reinforcement volume fractions up to 30%. The segregation of reinforcement particles as a result of different process variables and material properties that lead to the non-homogeneous metal distribution is a significant issue with stir casting. The different process variables include things like the degree to which metal particles are wet, relative density, settling velocity, etc. The speed of the stirrer, its angle, the presence of vortices, and other factors all have an impact on how the particles are distributed within the molten metal matrix. This method involves heating the matrix metal above its liquid temperature in order to completely melt it. It is in a semi-solid state once it has cooled to a temperature between the liquid and solidus states. The molten matrix is then supplemented with the previously heated reinforcement particles, which are then heated once more to a fully liquid state to ensure thorough mixing.

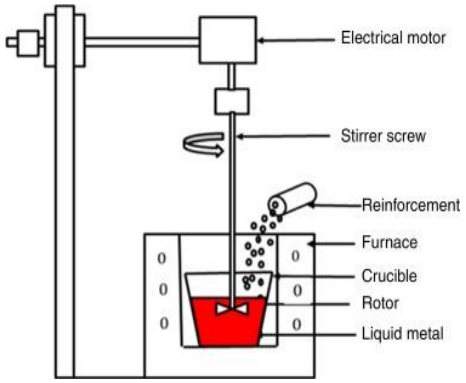


Fig.3. Stir casting Setup. [29]

3. Literature Review

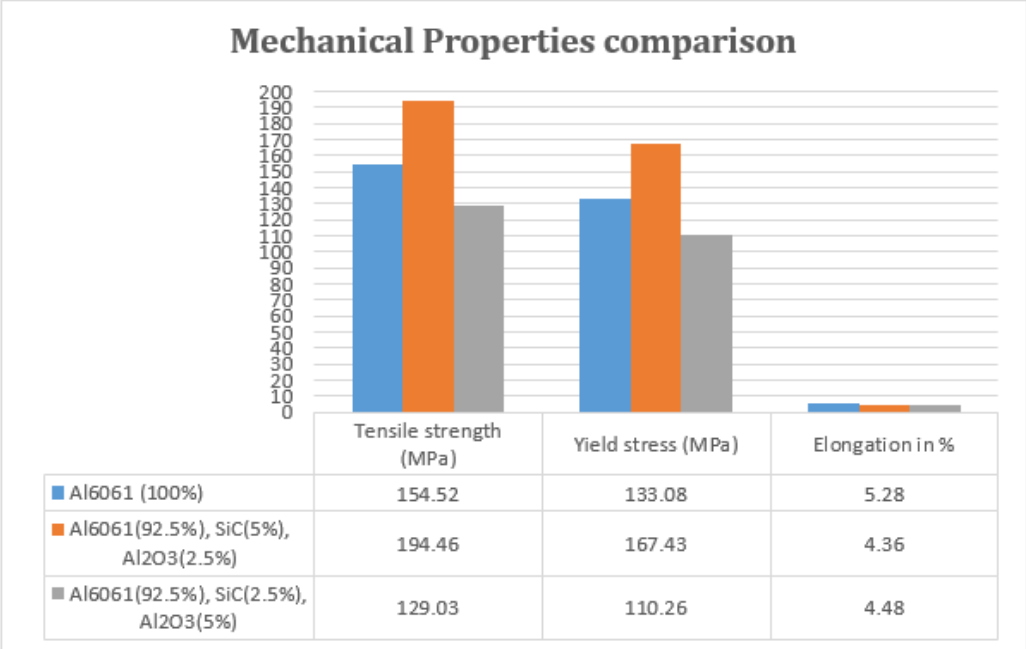
S.Arivukkarasan et al in is paper by Public was If only Aluminum LM6 could be reinforced with Silicon Carbide. In this manner, a strong and lightweight composite material would be created. Stir casting was used to create aluminium matrix composites with weight fractions of titanium dioxide and silicon carbide of 3:11, 7:9, and 5:5. The test of the mechanical properties was completed satisfactorily! Aluminum LM6 86%, Titanium dioxide 3%, and Silicon Carbide 11% all had significantly higher tensile, yield, compression, and hardness values. For the Aluminium LM6 90%, Titanium dioxide 5%, and Silicon Carbide 5%, the impact strength and percentage elongation were improved, whereas other properties were noticeably decreased. The microstructure of the composite of aluminium LM6, titanium dioxide, and silicon carbide has been observed to show homogenous distribution and excellent binding of titanium dioxide, at 3%, and silicon carbide, at 11%, with the aluminium LM6, at 86%, matrix, and noticeably less binding with uniform distribution of aluminium LM6, titanium dioxide, and silicon carbide, at 90%, 5%, and at 3%, respectively. [1]

Kamaal Haider et al. In demonstrated in their study the SiC and Al2O3 filled Al6061 alloy composites were discovered to be more efficient at supplying desirable properties in the castings. The hardness and strength of composites increased with increased ceramic particles content, according to experiments on SiC & Al_2O_3 filled Al6061 alloy composites. Better hardness and strength of composites and lower wear rates are attributed to finer grain sizes. [2]

Yadav Anshul et al. In investigated Due to the high density SiC reinforcements, the density of hybrid composite for S3 hybrid composite (12% SiC) was highest, whereas S2 hybrid composite (12% B_4C) had the lowest density due to low-density B_4C reinforcements. Due to an increase in void close to the location of the SiC reinforcement, the S3 hybrid composite (12% SiC) and S4 hybrid composite (9% SiC) exhibit the maximum porosity. The manufactured hybrid composites had porosities that ranged from 1.4 to 3.4%. The porosity and weight percentage of SiC/B_4C of the composites affected the hardness value. [3]

Siddharth Srivastava et al. Presented a paper on “Characterization of Aluminium Hybrid Metal Matrix Composites” and using the two-step stir casting procedure, an aluminium hybrid metal matrix composite was created. Along with tungsten carbide (WC), alumina (Al_2O_3), and rice husk ash in constant weight percentages of 2%, 3%, and 2%, respectively, silicon carbide was added to the AMMC in various weight percentages (5%, 10%, 15%, and 20%). Microstructural analysis and mechanical properties such tensile strength, hardness, density, impact strength, and flexural strength were carried out. [4]

S Ram Kumar et al. In evaluated the aluminium metal matrix composite is created utilising the stir casting method with various reinforcement compositions, including alumina and silicon carbide at weight percentages of 2.5% and 5%, respectively. As the weight percentage of silicon carbide increases, the composites' tensile strength rises. Due of the lack of reinforcing elements, sample 1 (Al 6061) absorbs less energy than the other samples. (Fig.4.) In comparison to the other two samples, sample 2 (Al6061 with 5% SiC and 2.5% Al_2O_3) has a greater Hardness rating. With regard to mechanical qualities, sample 2 (Al6061 with 5% SiC and 2.5% Al2O3) is superior to the other two specimens. [5]



	Tensile strength (MPa)	Yield stress (MPa)	Elongation in %
Al6061 (100%)	154.52	133.08	5.28
Al6061(92.5%), SiC(5%), Al2O3(2.5%)	194.46	167.43	4.36
Al6061(92.5%), SiC(2.5%), Al2O3(5%)	129.03	110.26	4.48

Fig. 4. Comparison of Mechanical Properties of Metal matrix composites. [5]

Ashish Srivastava et al. In investigated, It is shown that HMMCs produced via FSP are straightforward and exhibit great surface hardness and homogeneity. The majority of studies have so employed this strategy. yet results in lower wear resistance. Additionally, SiC and graphite are shown to be the most popular refractory materials. While graphite is used to soften and even wear rate is lowered, SiC is utilised to harden and increase mechanical qualities while simultaneously increasing wear rate. These MMCs can be processed using powder metallurgy (P/M), however getting a homogeneous distribution of graphite and SiC particles requires a fair amount of mixing time. [6]

Balamurugan Chinnasamy et al. In demonstrated in their study it has been discovered that the crucible casting method has been effective in incorporating silicon nitrate and eggshell (Si_3N_4 and Es) into the Al6082 matrix alloy. In comparison to conventional materials, composite materials, particularly those made of eggshell, magnesium, silicon nitrate, and aluminium 6082, have reached exceptional mechanical properties. It has a high toughness and can be utilised for a variety of industrial applications. As a result of the inquiry, the tensile, hardness, and compressive strengths of the Al6082 metal matrix have been analysed. In comparison to a pure alloy of Al6082, Ratio 2 (Al6082 + $Si3N_4$ 2% + Es 5% + Mg 1%) has been found to have greater tensile, hardness, and compressive strength. [7]

P. K. Farayibi et al. in is paper by Public This study has effectively evaluated the mechanical characteristics of Al-4043/SiC composites with different Ni-coated SiC reinforcing fractions. The eutectic Al-SiC microstructure of the composites was identified, together with SiC solid solution precipitates and SiC particles evenly dispersed throughout the Al matrix. It was discovered that the density of the composites increased linearly as the percentage of SiC reinforcement increased. With increasing SiC reinforcement percentage, it was discovered that the tensile strength, yield strength, and elastic modulus all increased. The highest values were achieved for composites with 25 weight percent SiC and were 350 MPa, 254 MPa, and 13.4 GPa, respectively.The composite with the most reinforcing had the lowest elongation, 10%, nevertheless. The composites' hardness, compressive strength, and impact energy all considerably rise as SiC content increases from 25 weight percent to 76 HB, 184 MPa, and 48 J, respectively. The greatest SiC reinforcement Al-4043/SiC composites were found to have an eleven-fold increase in wear resistance over the monolithic Al-4043 alloy.This study has effectively evaluated the mechanical characteristics of Al-4043/SiC composites with different Ni-coated SiC reinforcing fractions. The eutectic Al-SiC microstructure of the composites was identified, together with SiC solid solution precipitates and SiC particles evenly dispersed throughout the Al matrix. It was discovered that the density of the composites increased linearly as the percentage of SiC reinforcement increased. With increasing SiC reinforcement percentage, it was discovered that the tensile strength, yield strength, and elastic modulus all increased. The highest values were achieved for composites with 25 weight percent SiC and were 350 MPa, 254 MPa, and 13.4 GPa, respectively.The composite with the most reinforcing had the lowest elongation, 10%, nevertheless. The composites' hardness, compressive strength, and impact energy all considerably rise as SiC content increases from 25 weight percent to 76 HB, 184 MPa, and 48 J, respectively. The greatest SiC reinforcement Al-4043/SiC composites were found to have an eleven-fold increase in wear resistance over the monolithic Al-4043 alloy. [8]

Raj Kumar et al. In demonstrated in their study the wear rate of hybrid metal matrix composites and hybrid nano metal matrix composites for all applied loads, the weight fraction of micron- and nano-sized reinforced particles was increased to 1.8% and 0.6%, respectively. The hybrid metal matrix composites have a decreased wear rate at concentrations of Ni and Cr nanoparticles as low as 0.6 weight percent and Ni and Cr micron-sized particles as high as 1.8 weight percent. It was shown that raising the typical load caused an increase in wear rate. HNMMC and HMMC wear rates were reduced by 76% and 37.1%, respectively, at 10N. In comparison to monolithic Al6061 alloy and Al6061/1.8Ni/1.8Cr hybrid metal matrix composites, Al6061/0.6Ninp/0.6Crnp hybrid nano metal matrix composites have better tribological properties.Therefore, nano hybrid metal matrix composites have a better chance of enhancing mechanical behaviour. [9]

Johny James.S et al. In evaluated SiC and TiB_2 are present in the metal matrix and are distributed there, according to micro structural investigation. According to the results of the hardness measurement, adding reinforcements has an impact on the hardness value, however adding TiB_2 up to 5% results in porosity, which has an impact on the hardness value. Wear study has shown that TiB_2 particles improve the hybrid aluminium metal matrix's wear resistance characteristics. The machining study has revealed that TiB_2 reinforcement accounts for 38.86% of the surface roughness, making it the most important element. The value of surface roughness is increased by the addition of TiB_2 reinforcement. The following ideal machining settings are tabulated using Taguchi analysis to provide the best surface roughness: cutting speed of 120 m/min, feed rate of 0.3 mm/rev, depth of cut of 0.5 mm, and no TiB_2 reinforcement. [10]

Dr. S. Madhusudhan et al. In evaluated the stir casting procedure, rice husk ash and fly ash fragments were successfully integrated into the alloy Al 356.2. Al356.2/RHA/FA composites get harder as the rice husk ash percentage rises. With an increase in rice husk ash content, the ultimate tensile strength rises. As Fly Ash levels rise, the percentage of elongation rises as well. As the percentage of rice husk ash rises, so does the compressive strength. As the percentage of rice husk ash rises, so does the impact strength. In comparison to pure alloy, all hybrid examples demonstrated a higher improvement in mechanical properties. By using the stir casting procedure, rice husk ash and fly ash fragments were successfully integrated into the alloy Al 356.2. Al356.2/RHA/FA composites get harder as the rice husk ash percentage rises. With an increase in rice husk ash content, the

ultimate tensile strength rises. As Fly Ash levels rise, the percentage of elongation rises as well. As the percentage of rice husk ash rises, so does the compressive strength. As the percentage of rice husk ash rises, so does the impact strength. In comparison to pure alloy, all hybrid examples demonstrated a higher improvement in mechanical properties. [11]

Pardeep Saini et al. In demonstrated in their study SEM and OM have seen a consistent SiC particle distribution throughout the underlying Al-4032 matrix material for AMCs with up to 6% reinforcement. Localized reinforcement coagulation (creating adverse effects on homogeneity) has been seen at 8% weight fraction, indicating that the manufacture of the AMC is only suitable up to 6% reinforcement. At 8% reinforcement, the porosity is at its maximum. In general, the UTS and micro hardness of the AMC improve when SiC particles (up to 6% by weight) are added to the matrix. The characteristics start to deteriorate at greater weight fractions, or 8%, as a result of the reinforcement coagulating and weak interfacial bonding. As the SiC fraction increases with a decrease in the ductility of the Al-4032 matrix matter, elongation has been observed to be reduced. At 6% reinforcement, the minimum elongation is reached. The composites' impact toughness seems to be higher than the Al-4032 matrix's. At 4%SiC, the impact toughness reaches its maximum. Beyond this composition, there is a trend toward lessening impact hardness. [12]

M.Vamsi Krishna et al. In investigated in this study has been shown that the weight fractions have a significant impact on the mechanical properties of composites, such as tensile strength. The maximum tensile strength reported is 192.45 MPa at 15 weight percent SiC/Gr, according to research on the tensile strength of SiC & SiC/Gr reinforced hybrid particulate aluminium composites with various weight fractions. When compared to single reinforcement, the mechanical behaviour of SiC/Gr reinforced hybrid composites performed better. Studying the density of SiC and SiC/Gr reinforced hybrid particle aluminium composites with various weight fractions revealed that the density rises with SiC and falls with SiC/Gr hybrid particulates, making these SiC/Gr hybrid composites excellent light weight engineering materials. As per microstructure investigations, the matrix contains a consistent dispersion of reinforcing particles. [13]

K.R.Padmavathi et al. In evaluated the fabrication of hybrid Aluminium-SiC-MWCNT reinforced metal matrix Nano composites is discovered to be appropriate for the stir casting technique. SiC and MWCNT reinforcement of aluminium results in greater resistance to dry abrasive wear. With an increase in the percentage of MWCNT, the particular wear rate falls for all applied load values. The composites become harder as the hybrid ratio rises. This research serves as a foundation. To assess how SiC and MWCNT nanoparticles affect the wear characteristics of the hybrid composites, a thorough study is needed. [14]

N. Balaji et al. in demonstrated in their study in comparison to base Al alloy 6061, stir produced Al alloy 6061 with Al_2O_3 and TiC reinforced composites clearly outperformed it in terms of hardness value, according to the data. Al_2O_3 and TiC particles dispersed in an aluminium matrix increase the material's tensile strength. When turning aluminium HMMC, the response surface methodology was used to analyse the rate of material removal and the surface roughness. The analysis above led to the following findings. With increasing speed, feed, and depth of cut—in particular, increasing depth of cut will increase the chip thickness—the material removal rate increases from 0.48 Cm^3/min to 3.60 Cm^3/min. By reducing feed as well as depth of cut from 0.297 mm/rev, 0.45 mm to 0.1 mm/rev, 0.3 mm correspondingly, surface roughness lowers from 0.181 m to 0.038 m. These findings hold true for the mixture of AA606185p/Al_2O_3 10p/TiC_5p. Pure cast aluminium 6061 displays a surface roughness value of 0.031 m for the same speed, feed, and cut depth. When AA6061 and AA606185p/Al_2O_3 10p/TiC_5p are put side by side, the latter exhibits the best surface roughness value. The main cause is that as the volume % of Al_2O_3 and Tic increases, the work piece's hardness increases and surface roughness decreases. Additionally, it was found that as the depth of cut increased, so did the surface roughness values. It can be because increasing cut depth will result in more vibrations and cutting force, which will increase surface roughness. For assessing material removal rate and surface roughness in turning aluminium HMMC and AA6061, response surface approach is used. R2 > 0.95 indicates that the fitted value is extremely near to the experimental value. [15]

Shashi Prakash Dwived et al. In evaluated Fly-ash is a thermal power plant waste that pollutes the area around thermal power plant companies with both soil and air. It can be used successfully to fabricate composites. In order to create a hybrid composite material, which included fly ash as a secondary reinforcement material and Al_2O_3 as a primary reinforcement material, AA 6061 aluminium alloy was employed as the matrix material. The results showed that the tensile strength and hardness of the composite were increased by the addition of Al_2O_3 and Fly-ash to the AA 6061 alloy. The composite made of AA 6061+0% Fly-ash + 15% Al_2O_3 had a maximum hardness of 94 BHN. After heat treatment, a composite made of AA6061 + 7.5% Fly-ash + 7.5% Al_2O_3 was found to have a maximum tensile strength of 175 MPa. With the addition of ceramic particles, the AA6061 matrix material's toughness and ductility were lowered. The minimum toughness for sample number 8 (AA6061+0% Fly-ash + 15% Al_2O_3) was determined to be 6.5 Joule/m3. [16]

Nagender kumar chandla et al. In demonstrated in their study the carbide, oxides, nitrides, and agro-industrial reinforcements were successfully incorporated into Al-6061 MMC through the stir route of casting process, including SiC, B_4C, TiC, WC, TiB_2, Al_2O_3, TiO_2, ZrO_2, MoS_2, Fe_2O_3, Gr, FA, RM, CNT, and MWCNT in single, dual, and multiple reinforcements. The mechanical, tribological, and physical performance of Al-6061 composites were significantly improved by the accumulation of these reinforcements in particle form. The incorporation of particle reinforcements slightly improved the mechanical characteristics of

Al-6061 MMC. Al_2O_3, SiC, WC, and Fe_2O_3 among other reinforcements considerably increased the UTS, UCS, and hardness of cast Al-6061 MMC. Glass fibre, FA, and RM were additional reinforcements that helped the composites be stronger. However, when reinforcement weight percentage increased, the ductility and impact strength of reinforced composites declined. Al-6061 MMC's tribological characteristics, including as SWR, VWR, WR, WL, and COF, were greatly enhanced by the inclusion of solid reinforcements. The SWR and COF of Al-6061 MMC were greatly enhanced by the Gr, SiC, B_4C, and Al_2O_3 particulates. But because of its self-lubricating qualities and ability to produce a scratch-resistant layer on the surface of as-cast composites, Gr was thought to be the ideal reinforcement for tribological properties, improving the WR and COF of Al- 6061 MMC. Photomicrographs of the Al-6061 MMC's microstructural behaviour showed that, up to a certain level of reinforcement, uniform interfacial bonding and homogeneous distribution within the matrix were seen; however, many authors also reported the presence of some voids, clusters of particles, agglomerations, and cracks at higher weight fractions. However, the wettability and bonding between the solid matrix and particle reinforcements were improved by the inclusion of Mg and K_2TiF_6. Physical characterization revealed that the theoretical and experimental density of the Al-6061 alloy increased with higher concentrations of SiC, Al_2O_3, and Fe_2O_3 and reduced with higher concentrations of BA, B_4C, and CSA. Porosity% shown a direct correlation with the weight% of reinforcements in the most investigated feature. To minimise the density of Al-6061 composites with less porosity, light-weight B_4C, Gr, FA, BA, and CSA reinforcements were thought to be the most helpful reinforcement. [17]

J. Chandradass et al. Presented a paper on “Effect of silicon carbide and silicon carbide/alumina reinforced aluminium alloy (AA6061) metal matrix composite” Due to proper mechanical stirring action and homogeneous particle distribution, The presence of hard silicon carbide and aluminium oxide particles improved the properties of materials and wear characteristics of the aluminium (AA6061) alloy hybrid composite due to proper mechanical stirring action and homogeneous particle distribution. Tensile strength and hardness values of AA6061/7 wt% SiCp/3 wt% Al_2O_3 alloy are 27% and 25% higher, respectively, than those of unreinforced AA6061 alloy. According to the optical micrograph, silicon carbide and aluminium oxide particles are distributed uniformly in the hybrid AA6061 alloy matrix composite. The use of silicon carbide and aluminium oxide improved wear resistance, with the minimum wear rate being 2.5312x105mm3/Nm for a 40 N load and constant sliding speed. [18]

Adnan Adib Ahamed et al. In demonstrated According to the research, RHA may be successfully mixed into a pure aluminium matrix for the creation of composites. Additionally, this can address the issue of RHA storage and disposal as well as the use of agricultural waste. Stir casting was used to make composites by adding up to 9% by weight RHA to aluminium. The addition of magnesium boosted the RHA's retention in the composite by improving the RHA's wettability with aluminium melt. In comparison to the unreinforced state, the inclusion of RHA and magnesium increases the hardness of the composites from 22 BHN to 33 BHN. With a rise in RHA content and a decrease in density, the ultimate tensile strength and yield strength have both increased, allowing for the application of materials that are lighter in weight but stronger. [19]

S. Nallusamy et al. In investigated the metal matrix composites' hardness test revealed that Al-6061/20wt% SiC has a greater hardness value than Al-6061/10wt% SiC. By increasing the weight percentage of SiC from 10 to 20%, the hardness value in hybrid composites rises from 40 to 52.5, and in every composition, the value was higher than base alloy. SEM analysis revealed the presence of transverse and surface defects, as well as moderate and severe wear on the composite's worn surfaces and wear structure. It was discovered that by having access to SiC, which acts as a barrier to displacement movement, we might boost the wear resistance relative to the base alloy. The load of 10 N and 20 N, the sliding speed of 500 rpm, and the sliding distance of 1750 m all have a role in the wear rate. Additionally, a direct correlation between the wear rate and the increase in sliding distance was observed. The load of 10 N and 20 N, the sliding speed of 500 rpm, and the sliding distance of 1750 m all have a role in the wear rate. Additionally, a direct correlation between the wear rate and the increase in sliding distance was observed. [20]

Gaurav Mahajan et al. In demonstrated in their study in the microstructure, hexagonal-shaped crystals of TiB_2 and dendritic SiC are seen. The reinforcement is distributed uniformly throughout the microstructure, with occasional cluster formation. SiC and TiB_2 add a significant amount of hardness value to the Al6061 matrix. Al/10 SiCp exhibits a 38% increase in hardness, whereas Al/10SiCp/5TiB_2 exhibits a 35.7% increase in hardness iii. SiC and TiB_2 reduce the matrix material's wear rate and coefficient of friction. Due to dependence on different parameters, such as wettability and bonding between matrix and reinforcement, the hardness and wear values drop up to a specific point and then remain unaltered. The wear resistance of the composite may be lowered by excessive Al_3Ti flakes production. [21]

Ashok Kr. Mishra1 et al. In evaluated For Al - 6061/ 10% SiC metal matrix composites, applied load contributes 85.5% to coefficient of friction, while sliding distance contributes 13.4%. While the sliding distance contributes 13.4%. The most influential factor on wear rate is sliding distance (62.5%), followed by sliding speed (37.5%) and applied load (1.25%). The contribution of applied force is 87.2%, sliding distance is 9.7%, and sliding speed is 7.1% for Al - 6061/ 15% SiC metal matrix composites. The most influential factor on wear rate is applied load (57.2%), followed by sliding distance (7.1%), sliding speed (7.1%), and coefficient of friction (7.1%). By creating a protective layer between the pin and counterface, SiC inclusion (10% & 15%) boosts the wear resistance of composite materials. We expect that the sliding distance & applied load will have the biggest impact on wear rate in both composites based on the aforementioned conclusion. The only factor that significantly affects the coefficient of friction in both composites is the applied load, which is similar in both cases. The wear rate and coefficient of

friction of Al - 6061/ (10% & 15%) SiC MMCs for intermediate conditions were reasonably predicted using the regression equation created for the (10% & 15% SiC MMCs) current model. The results of a confirmation experiment and a comparison of experimental figures revealed that the coefficient of friction and error associated with dry sliding wear varied, respectively, in both composites, from 3.17% to 9.256% and 4.69% to 11.23%. Thus, the Taguchi approach of experiment design proved successful in predicting the tribological behaviour of composites. [22]

Ashish Srivastava et al. In evaluated Conclusion: Base alloy is clearly inferior than aluminium alloy with reinforcing. With its exceptional tensile strength, impact strength, wear resistance, hardness, and corrosion resistance, among other qualities, it enhances the mechanical properties. When compared to other materials, the fatigue properties of cast aluminium alloy also show better results, however occasionally porosity may produce less than ideal outcomes. Additionally, it is established that the base metal's electrical and thermal properties are enhanced when reinforcement is added. [23]

G.Anil Kumar et al. In investigated This research discusses the many reinforcement combinations employed in the synthesis of hybrid AMMCs and how they affect their performance. The application of the proper manufacturing techniques, depending on the choice of reinforcement, can efficiently construct AMMCs. Because reinforcement particles enhance mechanical qualities such as tensile strength, impact strength, wear resistance, hardness, and corrosion resistance, aluminium alloy with reinforcement is always preferable to base alloy. Among the different reinforcement particles, such as TiC, TiB_2, B_4C, SiC, Al_2O_3, and Gr. etc., it was discovered that B_4C has a greater hardness quality than the other reinforcements. [24]

Sunday aribo et al. demonstrated in their study in is known that the silicon carbide PAMC exhibits good mechanical characteristics at high temperatures. This material has high temperature capabilities, based on the stability and minor improvement in the yield strength, ultimate tensile strength, hardness, and ductility at higher temperatures. The impact strength is the sole characteristic that decreases as temperature rises. From the aforementioned, silicon carbide PAMC is suitable for high temperature applications in addition to its high specific strength and high specific modulus. [25]

4. Conclusion

After studying composites, we came to the conclusion that different fabrication techniques, which differ from metal to metal and depending on the alloy's physical state, can be employed to create composites. Since many researchers have utilised the stir casting process for their study, it has been discovered to be very cost-effective and advantageous for the production of composites. It may also be enhanced with ultrasonic assistance to improve the mixing of reinforcement in the melt. Stirring duration and speed are crucial factors that determine the composition of composite. The mechanical qualities of a composite depend on these factors, and by applying them optimally, we can enhance a variety of mechanical attributes like tensile strength, hardness, density, and microstructure.

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A Review on Design, Selection of Material, Analysis and Failure of Hooks used in Material Handling Equipment

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Abstract

Acrane hook is an accessory used with hoists or cranes to lift objects and move them from one location to another. A crane is used for continuous loading and unloading. This could eventually lead to the crane hook's fatigue failure. The crane hook, which lifts the weight, is a crucial component of the crane itself. Due to the High Concentration of Stresses, they are Subjected to, Hook on the Crane are Always at Risk of Failure. The goal of this study is to improve the crane hook's performance based on stress, geometry, and material choice. Analysed cross sections include square, round, and trapezoidal, all of which are subject to a concentric load. The curving inner surface of a crane hook constantly experiences concentrated load, where the greatest strains are created. This inner surface's curve is thought to be a significant area where failure could happen. Through the use of SOLIDWORKS Simulation, the analysis takes the shape of theoretical calculations and finite element analysis. Variations in the cross-sectional characteristics are used to optimise the weight and stress of the trapezoidal cross section, which is found to be the most effective. SOLIDWORKS software is used to create a solid model of the crane hook in order to examine the stress, strain, and deformation of the crane hook under load.By giving loading conditions, supports, and the relevant material parameters, ANSYS software is used to determine the stress distribution, strain distribution, and total deformation in the 3D model of the crane hook. In order to have improved qualities and achieve the best results, high strength material is chosen and heated. According to the investigation, trapezoidal-shaped crane hooks manufactured of alloy steel that has been hardened and tempered are ideal for use as crane hooks. By choosing the appropriate material in accordance with IS: 15560:2005 and lowering the number of patterns needed to forge each capacity of hook.

Keywords:Alloy1.2367(X38CrMoV53),Crane,Hook,Finite Element Method(FEM); lifting hook; topology optimization; fatigue analysis Solid works Software

1. Introduction

In industries, crane hooks are used for loading, unloading, and transferring big goods. The lower inner curve of the hook, which distributes the produced stress to the remaining portion of the hook, is typically loaded. In this work, analysis is carried out by altering the hook's cross section while maintaining a constant static stress. First, a SOLIDWORKS model of a 3D hook is created. Second, FEM software ANSYS is used before the static study on the hook. In order to reduce hook failure, it is important from a safety standpoint to analyse the stress placed on crane hooks. Hooks come in a variety of area cross sections. In this paper, design and analysis are done using the Hook trapezoidal cross section.

The load can be applied at the hook's bottom-most inner curvature point and the hook's highest point of support. Three important design factors that have a significant impact on the strength and weight carrying capacity of crane hooks are the material composition, cross sectional form, and moment of inertia. This work forges various capacity hooks using fewer patterns than the traditional method. For more than one capacity hook forging, we apply the same pattern by using material selection in accordance with IS 15560: 2005. After forging, we do a model-based stress study and comparison with an analytical method.

2. HOOK

A lifting hook is a device used for lifting loads by means of a device such as a hoist or crane.

Hook Manufacturing Methods:

1. Forging Hooks
2. From Sheet Metal Cutting (IS: 6216)
3. Fabricated Method

2.1. Types of Hooks

Fig. 1. Eye Hook

Fig. 2. Crane Hook

Fig. 3. Ramshorn Hook

Fig. 4. Single Hook

2.2. Design of hook assembly List of components to be used in hook assembly.

1. Hook
2. Cross bar (Cross piece)
3. Pulley
4. Shaft pin
5. Side plate
6. Bearing
7. Bearing cover
8. Bearing spacer

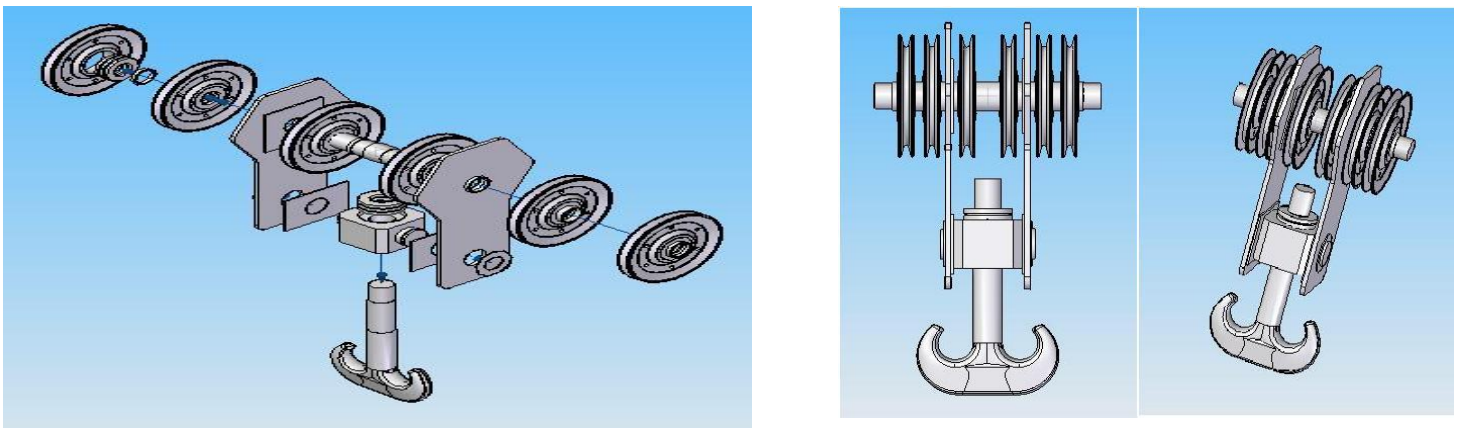

Fig. 5. Hook Assembly

2.3. Hook Failure

The crane is continuously loaded and unloaded. The crane hook becomes fatigued as a result; however, the fatigue cycle is quite short. The crane hook may shatter if a crack forms, which could result in a serious accident. In contrast to brittle fracture, ductile fracture prefers continuous crack propagation and easier detection. In brittle fracture, the crack spreads rapidly and the hook abruptly fails. Due to the difficulty in detection, this form of fracture is quite deadly. Continuous loading and unloading causes strain, which modifies the microstructure. Tensile and bending stresses, hook deterioration from use, and plastic deformation

Excessive heat strains and overloading are a few more causes of failure. Crane hooks may experience increased levels of these stresses over time, which could eventually cause the hook to break.

Fig. 6. Hook Failure

3. Literature Review

Bhimsen Shrestha et al in is the crane hook is successfully designed using the curved beam principle for five distinct cross sections, including circular, rectangular, trapezoidal, triangular, and t-section. The different sections of hooks were designed using the SOLID WORKS 2019 software, and the study of stress-induced deformation in the inner and outer profile was done using ANSYS WORKBENCH. According to the analysis, the stress induced in the trapezoidal cross section is smaller than that of the other four cross sections, indicating that crane hooks with trapezoidal cross sections are more resilient and have a better capacity to absorb and store displacement caused by vertical load (Fig. 7,8,9).[1]

Fig. 7. Circular Cross section

Fig. 8. Trapezoidal Cross Section

Fig. 9. Rectangular Cross Section

Ibrahim T. Teke et al in paper by Public Numerical analysis showed that the number of cycles to failure depending on the geometry of the hook.Among these studies, the most appropriate model is the third model. Fatigue life, damage, and safety factor; equivalent stress, and also total deformation having best result in the third optimized one.The first and second models are not appropriate at least for the loading of 5 tons (49050 N). The stress values of the models increase by about 30% when the first and second optimised models are employed. (Fig. 10) A conventional crane hook's fatigue life is reduced by around 70% by drilling holes behind the area of greatest stress and behind the weight. The third optimised model weighs 285 grammes less than the regular model but has a similar fatigue life to the actual model, which is a significant advantage from an economic standpoint.[2]

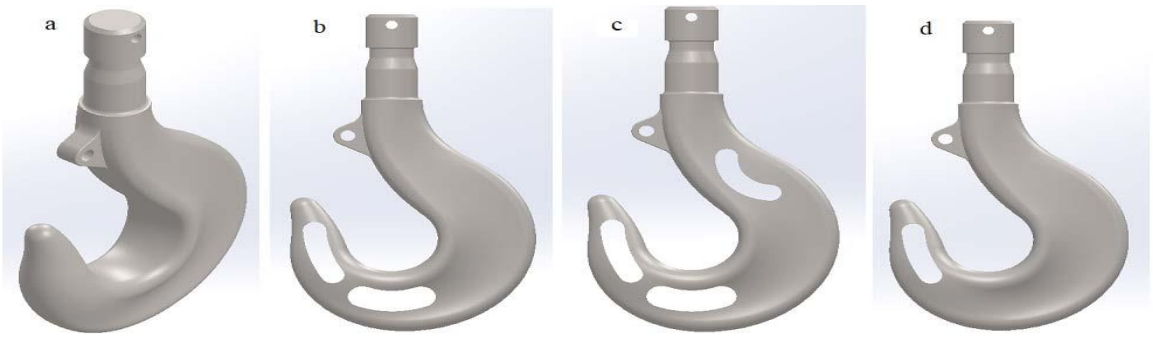

Fig. 10. (a) standard hook model; (b) first optimized model; (c) second optimized model; (d) third optimized model.

V Chandran et al in demonstrated in their in study The study examined crane hooks made of AISI 4340 alloy steel with vanadium at various concentrations. The findings showed that by enhancing crane hook material for more effective lifting and loading with proof of strong mechanical qualities and prolonged lifespan, failure can be minimised. The AISI 4340 alloy steels contain 99.95% AISI 4340 alloy steel and 0.05% vanadium, which together play a crucial role in creating the fine grain structure that improves mechanical qualities(fig.11). The study's findings suggest that using a crane hook made of 99.99% AISI 4340 alloy steel and 0.05% vanadium will result in high strength, dependability, and sustainability. When shipping heavy loads, it could beused.[3]

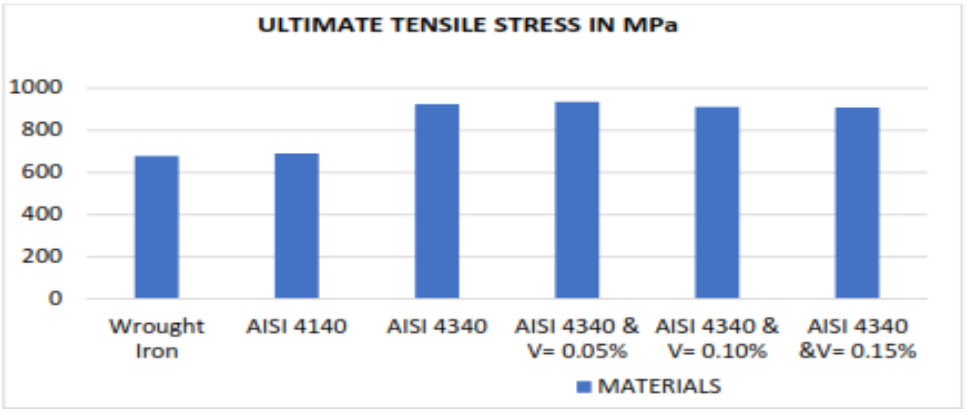

Fig. 11. Ultimate tensile stress in different composition of alloy materials

G Bhagyaraj et al. In is shown We could deduce from this study that Alloy 1.2367 (X38CrMoV53), which can withstand at the same rating and standards and provide significantly greater load capacities than the other hooks, can be used to manufacture crane hooks in place of traditional materials. reduces weight and allows mounting to a variety of cranes and hook blocks without altering the hook's design (Fig. 12, 13) [4]

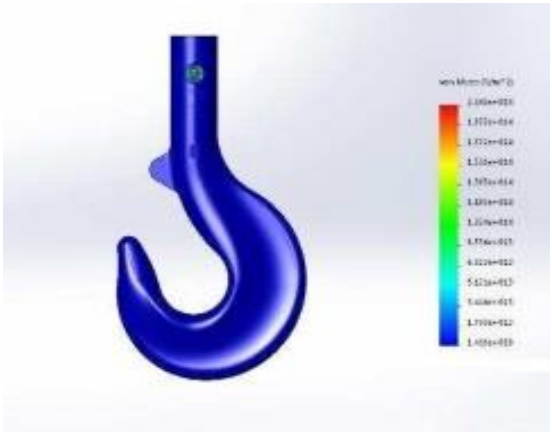

Fig. 12. Von Mises Stress

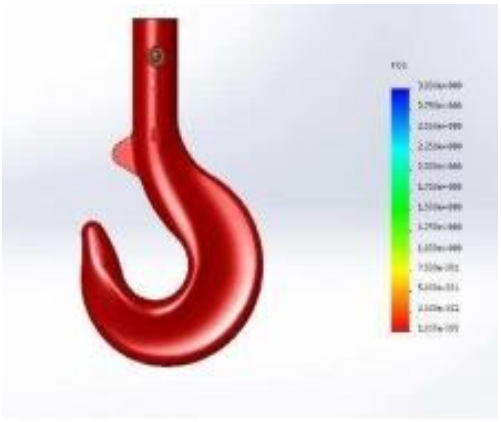

Fig.13. Factor of Safety

Nikhil R. Patel, Nilam kumar , S. Patel et al. In is shown Design of 50 Ton Hook with Analytical Method and Then Create Solid Works model and Analysis on Ansys. Result will compared**.**The entire work is an effort to develop a FEA process for measuring stresses by validating the outcomes. Estimating stresses, their magnitudes, and potential locations is crucial for lowering hook failure rates. The major goal of this study is to increase the crane hook's ability to endure structural and bending stresses while simultaneously lowering the crane hook's stress concentration. Therefore, the additional scope of work involves optimising the crane hook design by adjusting variables like the inner and outer thickness of the crane hook cross section. [5]

Fig. 14. Solid Works Model of Crane Hook

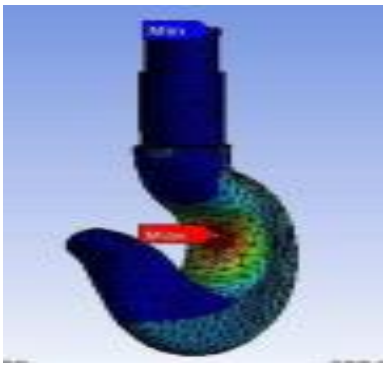

Fig. 15. Maximum Shear Stress Formula

Suman Pathak, et al in paper by to determine the maximum stress, strain, and deformation, a linear static structural analysis has been done after looking at the computation above. Peak stress of 4.017 10 Nm2 is discovered. With a safety factor of 2.64, it can withstand loads up to 2.64 times greater than those used in the experiment. The same calculations and analyses can also be performed using FEM and ANSYS, which is useful for studying stress, displacement, strain fracture point, and numerous other minor calculations at each location. The load can be applied at the hook's bottom-most inner curvature point and the hook's highest point of support. Three important design factors that have a significant impact on the strength and weight carrying capacity of crane hooks are the material composition, cross sectional form, and moment of inertia. This work forges various capacity hooks using fewer patterns than the traditional method. For more than one capacity hook forging, we apply the same pattern by using material selection in accordance with IS 15560: 2005. After forging, we do a model-based stress study and comparison with an analytical method. [6]

Pappuri Hazarathaiah et al. In evaluated Results of stress analysis derived from FEA analysis for a variety of materials, including Forged Steel, Wrought Iron/MS, and Aluminium Alloy. When using different material topologies with the same tone, it is apparent that the results will vary. However, the forged steel material, which is described in the table below, is determined to give the least amount of stress in the above table (Fig.16).[7]

Material	**Analytical stress** (N/mm2)	**Tone**	**Max.Equivalent Stress** (N/mm2)
Forged Steel	98.5	5 tone (49050 N)	103
Wrought iron	125.1	5 tone (49050 N)	113
Aluminium alloy	128.6	5 tone (49050 N)	124

Fig. 16. First Trial Of Hook Design For Forged Steel

Mukesh Sonava et al. In is shown the research we conducted here provides a review of earlier works in journals and publications that are based on various concepts that have been modified using analytical and computational techniques. Here, in this section, we draw a conclusion about the key factors that we examined through research into earlier work. 1. The major portion concentrates on the several crane hook cross sections (trapezoidal, T section, I section, and triangular section).2. The force placed on the crane hook when it is loaded was also a point of emphasis. 3. The literature also demonstrates the usage of various materials in crane hook production. 4. Work is also being done to lighten the hook. 5. The solid model of a hook is subjected to certain experimental methods in order to determine the deformation under stress. [8]

Yadav Bhola Chunkawan et al in paper by determine in order to determine the highest levels of stress, strain, and deformation at the blade, disc, and fillet regions, linear static structural analysis has been done. It is discovered that the hook experiences a peak stress of 310.45 Mpa and total deformation of 2.423 mm. discover Crane hooks' initial modes and accompanying natural frequencies (Fig.17). Crane hook fatigue analysis was done for 1000000 startup and shutdown cycles, and the design was found to be safe because the fatigue life findings were beyond 100000 cycles. Crane hook optimisation reduces weight by 12.1 kg,

extending crane hook life and improving efficiency. [9]

Sl.no	Equivalent stress	Maximum principal stress	Minimum principal stress	Weight
Chrome steel	310 mpa	296 mpa	62 mpa	18.614 kg
Aluminum	311mpa	297mpa	63 mpa	6.5682 kg

Fig. 17 Material Comparison

E.Sai Krishna, Dr. S .Suresh kumar et al. In is shown The research We have successfully optimized the material of the crane hook study the structural stresses of hook by ANSYS R15.0 & concluded that the material which is having less deformation will have more stability if less failure of crane hook.Final we got the material SAE-AISI 1040 with less deformation.so it is the material suitable for crane hook.[10]

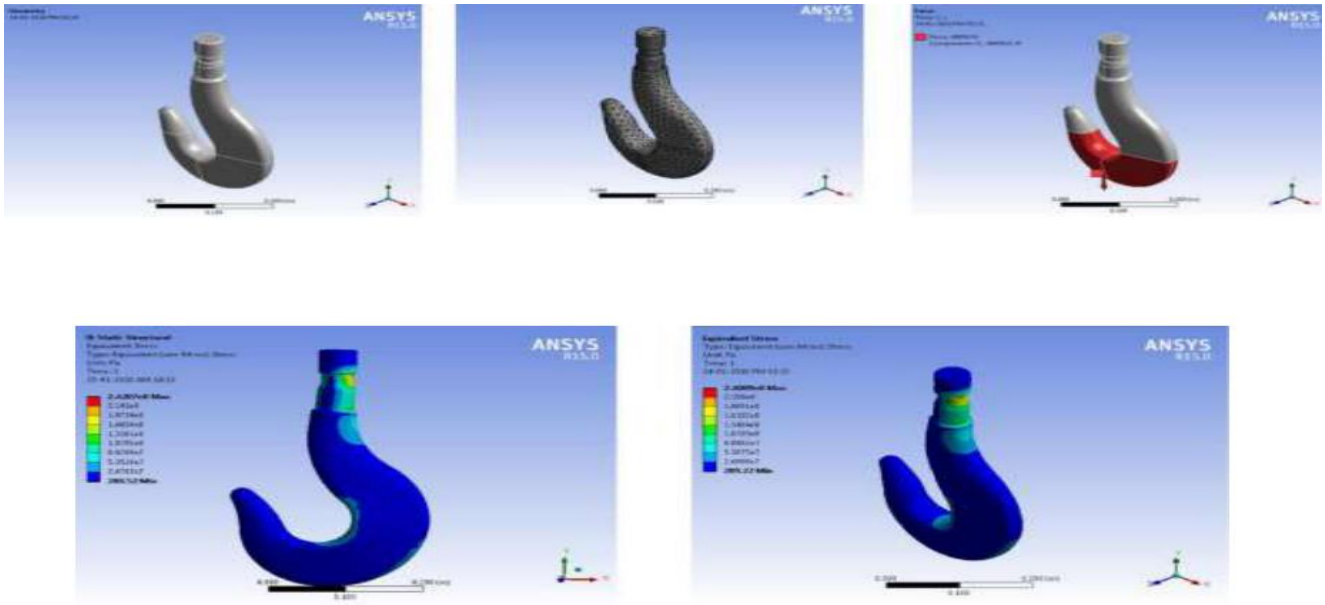

Fig.18. Design and Analysis of Different Grade Materials

Osman Ashraf Ansari et al. In is shown the research that The Pro/Engineer wildfire 5.0 model that was examined with Ansys V12.1. Ansys receives the model developed in Pro/Engineer in IGES (Initial Graphics Exchange Specification) format. The model has undergone a structural analysis using the suggested material parameters, boundary conditions, and loads. By looking at the findings that were covered in the first chapter, it can be concluded that the crane hook model can support the suggested loads while taking a factor of safety into account of 1.2. So, after considerable testing, the planned model can be produced or constructed [11].

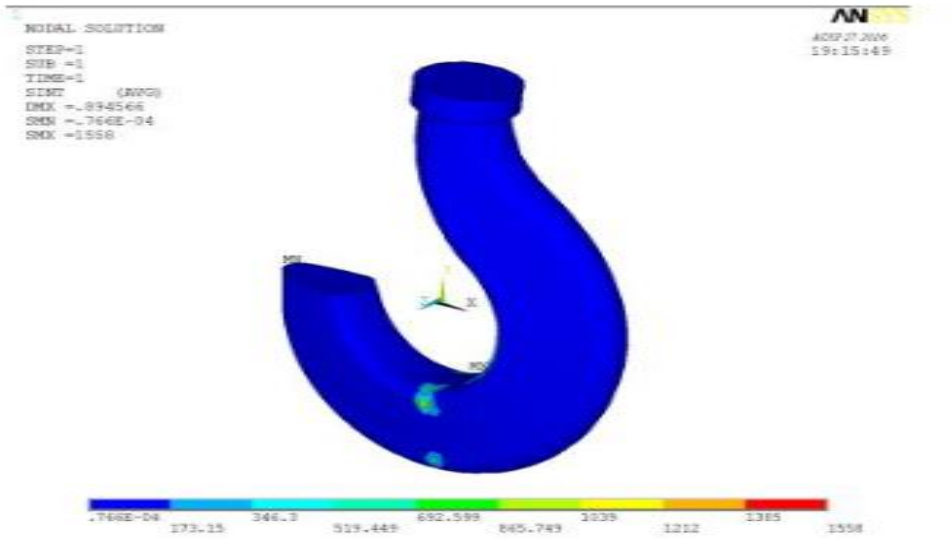

Fig. 19. Stresses in Crane Hook

MOH Ahtesham Mansuri, et al. In is shown the research that Stress concentration criteria are frequently used, among other things, to gauge the sturdiness and durability of machine parts. By examining the strains produced on the crane hook, one can reduce the likelihood of a failure. Since there haven't been many studies in this field, it is acceptable to conclude from an analysis of earlier works that curved beams, such as crane hooks, require additional study. The Finite Element Method (FEM) is one of the best and most potent techniques for stress analysis of the crane hook among those that are accessible, according to the literature review [12].

Fig. 20. Single Crank Hook

Santosh Sahu,Ritesh Dewangan,Manas Patnaik,Narendra Yadav et al. In is shown the research that on the basis of the findings from the Finite Element Analysis and Design of Experiment carried out for the trapezoidal cross section crane hook, we have come to the following conclusions: The site where the maximum tension was produced and its magnitude. The Figure (21) illustrates how the amount of energy held within the crane hook reduces when the outer parallel length (b) of the trapezoidal section is increased. The crane hook's energy storage capacity reduces as inner parallel length (B) of the trapezoidal section increases, as shown in Figure (22).[13]

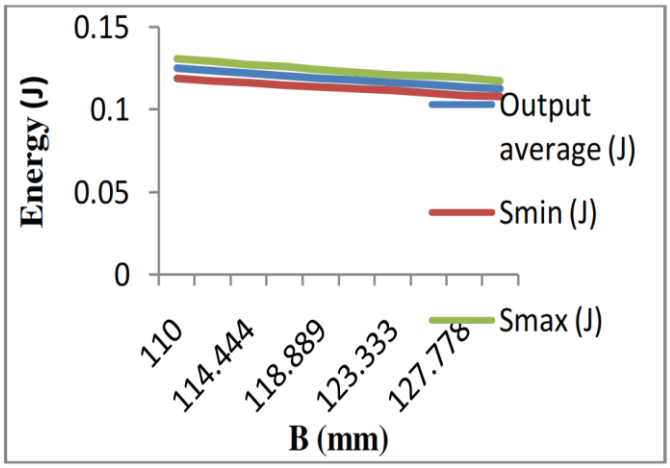

Fig. 21. Graph Plotted Between Energy Stored

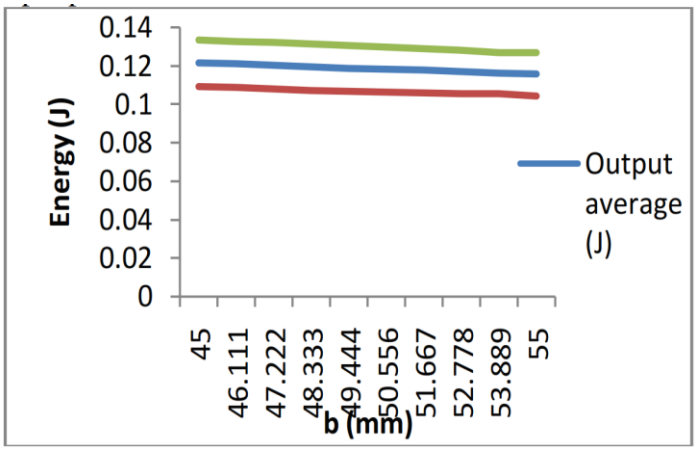

Fig. 22. Displacement Graph

Sumit Bundela, Ashish Kumar Shrivastava et al. In is shown the research that FEA software has been used to analyse the crane hook. The hook model is created using ANSYS, and its maximum primary stresses and deformation are examined. On the hook, a load of around 4 tonnes is applied. The load is applied using cross sections including circular, triangular, trapezoidal, and rectangular. A study was conducted using these models to examine how stresses and the material's flow behaviour were affected by changes in cross sections, and the following conclusion was reached:Trapezoidal cross sections were produced with a main stress of 140.13 MPa as the lowest possible value.Additionally, a trapezoidal cross section is observed to have a relatively lesser material flow[14].

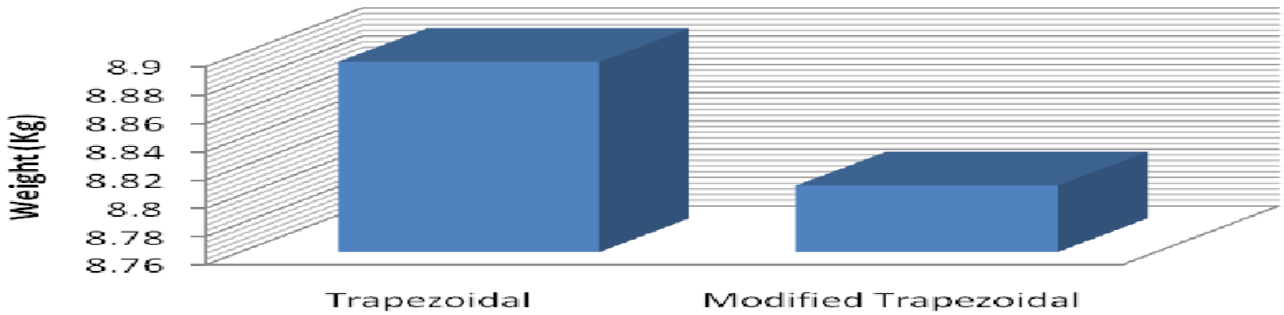

Fig.23. Graphical Comparison Between Trapezoidal and Modified Trapoidal Cross Section

4. Selection of Material

4.1. Chemical Property

Industrial Hook are Designed as per IS: 15560:2005.
Generally, In Hook Manufacturing 4 Grade of Hook are available in Market.

1. Grade L
2. Grade M
3. Grade S
4. Grate T

Grade L and Grade M not Need Hardening Process but in Grade S and Grade T has to Follow Hardening Process after Process.

Here I have Selected Class II IS: 1875 and Class III IS: 1875

Class 1A and class 3 steels of IS: 1875 may be used for Grade L and Grade M hooks.

IS 4367 may be used for Grade Sand Grade T hooks. This standard applies to the drop-forged and open-die forged eye hooks up to a safe working load from 0.63 to 160 tonne.

Table 4. IS :1875 :1992 Tensile Property and Hardness

(*Clauses* 1.1, 6.1, 6.2.1, 6.3 *and* 12.1.1)

Class	Designation [*See* IS 1762 (Part I) : 1974]	Constituent, Percent				
		Carbon	Silicon	Manganese	Sulphur *Max*	Phosphorus *Max*[1]
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	14C6	0·10—0·18	0·15—0·35	0·40—0·70	0·04	0·04
1A	15C8	0·10—0·20	0·15—0·35	0·60—0·90	0·03	0·04
2	20C8	0·15—0·25	0·15—0·35	0·60—0·90	0·04	0·04
2A	25C8	0·20—0·30	0·15—0·35	0·60—0·90	0·04	0·04
3	30C8	0·25—0·35	0·15—0·35	0·60—0·90	0·04	0·04
3A	35C8	0·30—0·40	0·15—0·35	0·60—0·90	0·04	0·04
4	45C8	0·40—0·50	0·15—0·35	0·60—0·90	0·04	0·04
5	55C8	0·50—0·60	0·15—0·35	0·60—0·90	0·04	0·04
6	65C6	0·60—0·70	0·15—0·35	0·50—0·80	0·04	0·04

	CHEMICAL PROPERTIES				
	C	Mn	Si	S	P
Designation	*%*	*%*	*%*	*% (max)*	*% (max)*
20C8	0.15-0.25	0.60-0.90	0.05-0.35	0.050	0.050
25C8	0.20-0.30	0.60-0.90	0.05-0.35	0.050	0.050
30C8	0.25-0.35	0.60-0.90	0.15-0.35	0.050	0.050
35C8	0.30-0.40	0.60-0.90	0.15-0.35	0.050	0.050
40C8	0.35-0.45	0.60-0.90	0.15-0.35	0.050	0.050
45C8	0.40-0.50	0.60-0.90	0.15-0.35	0.050	0.050
50C8	0.45-0.55	0.60-0.90	0.10-0.35	0.035	0.035
55C8	0.50-0.60	0.60-0.90	0.15-0.35	0.050	0.050

4.2. Material Selection Justification

In General Class 1A, Class II and Class III Material are Used in Industry. Reason of that is Class 1A Class II and Class III Material EN Equivalent Chemical Composition is Available in Market easily.

For Prize Comparison these Class Material are easily available in Market and available at Forging Industry for Forging Hooks**.**

5. Conclusion

Further all Research are dealing with Stress Analysis by Numerical Method,Stress Analysis by Various Finite Elements Method. Hook Modeling by Various Soft wares like Solid Works Solid Modeling. Stress Developed on Various Cross section Like Circular Cross Section, Trapezoidal Cross Section, T Section, I Section, Circular Cross section. Among These all-Cross Section

Trapazoizal Cross Section having Less Stress induced and having More Load Carrying Capacity compared to all other Cross Section. By Use of Vanadium in AISI 4340 Alloy Steel used for reducing Weight of Hook as Compared to all other Material used for Hook Forging. Stress induced in Material Wrought Steel, Forged Steel, Alloy Steel, Aluminium Alloys we can conclude that Alluminium Alloy Steel is more durable than other Material so most Versatile used material is Alloy Steel. Stress Developed during Operation most versatile numerical method used is Numerical Method and FEA Method.

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The Evolution of Phishing Attacks: Spoofed Email Detection Technique Using Slam Model

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Abstract

Phishing is a type of identity theft in which Internet users are duped into disclosing personal information such as login credentials, credit/debit card details, and so on. In recent years, researchers have created a variety of anti-phishing technologies. However, the issue persists. As a result, this study paper provides a thorough examination of phishing attack strategies and detection procedures. The research was divided into three phases: a first phishing attack, knowledge transfer using a mixed-approach, and a second phishing attack with new material. Following data validation and analysis, it was discovered that people's degree of cyber security awareness improved dramatically. The proportion of people that opened the phishing email fell by 71.5%. As a result, the proposed technique can improve cyber security in many organisations and sectors/industries by identifying E-mail spoofing with the SLAM model. It will also assist various users in avoiding phishing assaults while using the Internet for their daily activities, and new tactics will advise administrators in detecting phishing risks such as email spoofing.

Keywords: Phishing, Theft, Anti phishing, Spoofing, Detection, SLAM Model.

1. Introduction

The advancement of technology and communication systems ushered in a new era of digital movement. People and businesses today rely nearly entirely on technology for their operations. It improved efficiently, but this approach has also increased the risk of threats; the growing use of technology means that crucial infrastructure components are vulnerable to phishing attempts. [1, 2].

Technology has made everyone's life much easier. People can get anything with a single click and store data in one place. However, it has also become a nightmare because it has made it easy for hackers to steal data through phishing assaults. This situation is becoming increasingly severe as a result of the massive surge in cybercrime.

Hackers deploy various sorts of social engineering assaults; securing the information of vital infrastructure and databases from such disruption and attacks is critical, and will be one of the primary issues in the future. Phishing is one of the most well-known social engineering attacks. It is often used by hackers to entice victims to give sensitive and personal information. [3, 4].

Terrorists use phishing attacks to promote propaganda and disinformation, raise funds, plan campaigns, and offer information on them. In the future, they may attempt to launch attacks on the country's essential infrastructure. As a result, fighting them with intelligent systems capable of detecting, evaluating, and responding to phishing assaults have become a need [23].

Furthermore, phishing assaults are not localised; they are a global hazard that poses a threat to any system in the globe at an increasing rate. This is why we require creative techniques such as the faked E-mail strategy using the SLAM model, which provides learning power to software and will aid humans in combating such attacks. [11, 15].

The purpose of this study is to present applying spoofed e-mail detection techniques for phishing attacks, to demonstrate how these techniques can be effective for detection & prevention of phishing attacks, as well as to give the scope for future world.

2. Phishing: Definition, Need, Lifecycle and Issues.

2.1. Phishing Attack and Issues

Phishing is a type of cyber assault that employs email, phone, or text messages to encourage people to provide personal or sensitive information, such as passwords, credit card information, and social security numbers, as well as information about a person or organisation [1].

Phishing is a type of identity theft that deceives Internet users into disclosing personal information; in recent years, researchers have created a variety of antiphishing solutions. However, the issue persists. As a result, this study provides a thorough examination of phishing attack strategies and detection procedures [13].

Phishing attacks are typically carried out through the use of emails. The word "fishing" is derived from the words "password harvesting" and "fishing for passwords." "Brand spoofing" is another term for it. Phishers are con artists. The term 'phishing' was first used on January 2, 1996. During the 1990s, hackers would pose as AOL administrators and phish for login credentials in order to gain free internet access. Phishing began to evolve at a rapid pace in the 2000s and 2010s. Phishing was the most common cyber crime in 2020, according to the FBI's 2020 Internet Crime Report, with over 240,000 victims and a loss of more than $50 million. And the number of victims has more than doubled since 2019 and is almost ten times higher than in 2018[17].

Phishing accounts for more than 80% of all "social actions," another term for social engineering attacks, making it by far the most common sort of such an attack. Furthermore, the survey claims that 96% of social acts are sent by email, with only 3% delivered via website and 1% submitted via phone or text. Phishing attacks are typically carried out via email [23].

With an understanding of the specific environment, the detection technique analyses the many hazards that may exist in the given area. It then aids in the development and execution of plans to fight harmful assaults or threats. A wide range of diverse activities are engaged in detecting strategy for defending the concerned entity as well as rapid response to a danger landscape. These could include decreasing the environment's attraction to potential attackers, identifying vital locations and sensitive information, executing preventative controls to ensure attacks are costly, attack detection capability, and reaction and response capabilities. The detection technique also does technical analysis to determine the paths and regions that the attackers could target [5, 6].

The spoofing approach provides the much-needed confidence that operations and activities can be carried out without fear of danger. It aids in the most efficient use of security strategy and resources. It also aids in enhancing the effectiveness of security resources and security expenses, particularly in vital places [7, 8].

Phishing dangers saturate every company and are not usually directly under the authority of IT. Business leaders are pushing forward with digital business initiatives, and those leaders are making technology-related risk decisions on a daily basis. Increased phishing risk exists, but so are data security solutions [12].

The phishing system is critical for the government and other organisations that have a direct impact on the wellbeing and safety of the nation - or the planet - or the organisation. Phishing assaults on governments, military organisations, defence suppliers, and individuals are beginning to augment or replace physical attacks, placing nations at risk [13].

Antivirus software and firewalls no longer prevent these attacks. The risk of cyber attacks is continually increasing, and it is no longer a question of "if" but rather "when" it will occur for businesses and institutions. This is why a spoofing e-mail detection system is so critical. Security is vital because it includes everything

related to protecting our data from cyber attackers who wish to steal it and use it to inflict harm. This can include sensitive data, information from government and industry, personal information, personally identifiable information (PII), and intellectual property [22].

One of the most difficult aspects of e-mail security is ensuring the safety of our data. Ransomware, phishing attacks, malware attacks, and other threats are examples of challenges. India ranks 10th in the world in terms of local cyber-attacks, with 121 million occurrences already recorded in 2021 [3].

List of the top challenges of cyber attack system:

- Ransom ware attacks
- IOT attacks
- Cloud attacks
- Phishing attacks
- Block chain and Crypto currency attacks
- Software vulnerabilities
- Machine learning and AI attacks
- BYOD policies
- Insider attacks
- Outdated hardware
- Intelligence/awareness

2.2. Lifecycle of Phishing Attacks

The lifecycle of phishing attack is shown in Figure 1. A Phishers uses following steps to take the user's credential:

Step 1: Planning and Setup: First, the Phishers identifies the target organisation and prepares the technical strategy to acquire secret information.

Step 2: Phishing Site Construction: Then, Phishers creates a phishing website that looks similar to the official website. Various online tools are available which generate a replica of a well-known website (HTTrack Website Copier- Free Software Offline Browser (GNU GPL) 2017). Cui et al. found that 90% of the malicious sites are the replica or modification of previous phishing attacks (Cui et al. 2017). After constructing the website, Phishers uploads these files to a web-hosting server.

Step 3: Phishing Spreading: Then, attacker chooses the appropriate distribution method to spread the link of the phishing website. Later, Section 3 will discuss the various phishing distribution methods.

Step 4: Installation: The fake link redirects the user to the malicious website where the user may end up providing credentials. The fake link may install some malicious software on user's system.

Step 5: Data collection: Phishers can access the data filled by the Internet user. Moreover, malicious software can also send the information stored at user's system.

Step 6: Break-Out: After receiving the user's credentials, the cybercriminals delete all the evidence, that is, the phishing websites, email accounts, and so on. The attacker can use user's credential (e.g. credit card details, username, password, etc.) for malicious purposes [28].

2.3. Motivation of Attackers

Following are the intentions of attackers behind the phishing attack

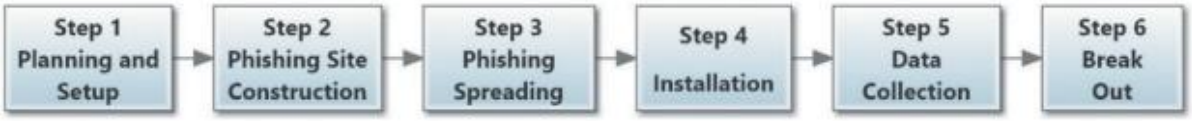

Fig. 1: Lifecycle of Phishing Attack

- Financial benefits: Stealing money from the end users is the main reason to perform phishing attacks.
- Impersonate identity: Attackers mimic the identity of legitimate user/enterprise to execute illegal projects.
- Gaining Fame and dignity: Web criminals may attack Internet users to achieve the fame and recognition.

3. The Impact of Spoofed E-Mail Technique with SLAM Model

Because the scope of risks has increased beyond what people can manage, it is now critical to automate threat detection and management. The spoof e-mail detection technique assists in automatically analysing online traffic and investigating questionable activity. SLAM can detect assaults before attackers have access to important information. In addition, the AI engine continuously learns from the huge amounts of data it analyses. This form of lifelong learning enables the organisation of the defence system to be automated, allowing it to tackle prospective attacks on its own. Detection is seen as a science that discovers solutions to complicated situations that cannot be solved without the use of intellect. Some strategic applications in the realm of cyber are increasing as a result of the manner in which computers replicate human intelligence activity. such as thinking, learning, planning etc [4, 7, 8].

The impact of spoofed email detection technique can be significant and can help mitigate the risks associated with spoofed emails. Some of the benefits of detecting spoofed emails include:

1. Reduced phishing attacks: By detecting spoofed emails, organizations can prevent phishing attacks that attempt to trick recipients into revealing sensitive information or downloading malware.

2. Improved security posture: Detecting spoofed emails can improve the overall security posture of an organization, as it helps to identify and block malicious emails before they can do harm.

3. Protection against BEC attacks: Spoofed email detection techniques can also help protect against business email compromise (BEC) attacks, where attackers impersonate high-level executives or vendors to trick employees into making fraudulent financial transactions.

4. Enhanced reputation: By preventing spoofed emails from being delivered, organizations can protect their brand reputation and avoid damage to their image caused by fraudulent emails being sent under their name.

5. Compliance with regulations: Many regulations, such as SLAM and HIPAA, require organizations to implement measures to protect personal and sensitive data. Detecting spoofed emails can help organizations comply with these regulations and avoid fines or legal penalties.

Overall, faked email detection systems can have a substantial impact and can assist organisations in reducing the risks connected with these types of assaults. Implementing advanced email security solutions, such as SLAM, can assist organisations in detecting and preventing the delivery of spoofed emails, resulting in a safer and more secure email environment [25, 26].

3.1. Spoofed e-mail Detection

The general problem of simulating intelligence has been simplified to specific sub-problems.
Which have certain characteristics or capabilities that an intelligent system should exhibit? The Following techniques have received the most attention.

- Sender Policy Framework (SPF): SPF is a DNS-based email authentication system that determines whether or not the transmitting IP address is authorised to send emails on behalf of the domain. SPF works by defining a list of authorised sending servers in DNS records, which email servers can use to validate the sender's IP address.
- Domain Keys Identified Mail (DKIM): DKIM is another DNS-based email authentication mechanism that employs cryptographic signatures to authenticate the authenticity of email messages. DKIM works by adding a digital signature to the email's header, which can be checked by the recipient's email server to confirm that the message was not tampered with in transit.
- Domain-based Message Authentication, Reporting, and Conformance (DMARC): DMARC is a DNS-based email authentication protocol that combines SPF and DKIM to give a full email authentication solution. DMARC allows domain owners to establish policies for how their emails should be handled if they fail SPF or DKIM checks, such as being rejected or sent to a quarantine folder.
- Content-based filtering: Content-based filtering is a technique for detecting phishing attacks and other malicious activity by analysing the content of emails. This can include inspecting the email's subject line, body text, and links for suspicious content.
- Machine learning and artificial intelligence (AI): Machine learning and artificial intelligence (AI) can be used to analyse massive amounts of email data and find trends that suggest phishing attacks or other harmful behaviour. This can include analysing email headers, IP addresses, and user behaviour to detect and prevent malicious activities [27, 28].

Overall, there are several different types of spoofed email detection techniques that organizations can use to protect against email spoofing and phishing attacks. Implementing a combination of these techniques can provide a comprehensive email security solution that helps protect against a range of threats.

Many solutions for safeguarding data across networks and the Internet have been created (for example, antivirus software, firewalls, encryption, secure protocols, and so on); yet, adversaries are always developing new ways to attack network systems. A detection and prevention system (DPS) is a software or hardware device installed within a network that can detect and prevent potential intrusions. DPSs perform four essential security functions: monitoring, detection, analysis, and response to unauthorised activity [14, 20].

4. Application Of Spoofed E-Mail Detection with SLAM

According to Wang et al. (2008), the application of Heuristic Technology, which means "the knowledge and skills that use some methods to determine and intelligently analyse codes to detect the unknown virus by some rules while scanning," is the future of anti-virus detection technology. According to scholarly literature, AI approaches have a wide range of applications in preventing cybercrime. For example, neural networks are being used to identify and prevent intrusions, but there are also plans to use neural networks in "Denial of Service (DoS) detection, computer worm detection, spam detection, zombie detection, malware classification, and forensic investigations." SLAM Heuristics, Data Mining, Neural Networks, and AISs techniques have also been applied to next-generation anti-virus technologies. Some IDSs use intelligent agent technology which is sometimes even combined with mobile agent technology. Mobile intelligent agents can travel among collection points to uncover suspicious cyber activity. This section will briefly present related work and some existing [21].

In the context of phishing, the terms S, L, A, and M refer to the various components of an email message that can be analyzed to detect phishing attempts.

S (Sender): The sender of an email can be a key indicator of whether the email is legitimate or a phishing attempt. Phishing emails often use spoofed sender addresses to appear as though they are coming from a trusted source. By analyzing the sender's email address and other metadata, such as the sender's IP address or email authentication records (such as SPF or DKIM), the SLAM method can determine whether an email is likely to be legitimate or not.
One common tactic is to include a real company's address inside their fake one. For example, the sender's email might be @emcom.bankofindia.com, where the scammer is pretending to be from Bank of America, using the real company's URL in a new domain to trick you.
You can quickly determine whether the email is a scam by searching the address used. You'll likely find warnings that tell you it is a phishing email.

L (Links): Phishing emails often contain links that direct users to fake login pages or other malicious websites. By analyzing the URLs of these links, the SLAM method can determine whether they are likely to be legitimate or part of a phishing attempt. For example, the SLAM method can check whether the domain name matches the sender's email address or whether the URL uses HTTP or HTTPS protocol.
Hover Over Links (L) Before Clicking:
A popular way scammers get their target's information is with the use of hyperlinks. Many people believe their anti-virus filters will protect them from clicking these links, but they do not. Anti-virus software can filter any attachments that may contain malware, but in the case of a hyperlink, the actual link is not unsafe. What's unsafe is the site it takes you to if you click on it.
These links can come in many different forms: text links, images or buttons within the email. Before clicking on a link, you need to hover over it to see the URL. Noticing a sketchy URL will immediately tell you that the email is a scam.

A (Attachments): Phishing emails may also contain malicious attachments, such as infected files or malware. By analyzing the content and file type of attachments, the SLAM method can determine whether they are likely to be legitimate or part of a phishing attempt. You used to be able to tell if an attachment was OK based on the type of file it was. Not anymore. Criminals can now infect all types of files with malware, including PDFs,and who wouldn't quickly click a file labelled as a sales order or invoice? File attachments are widely used in phishing emails simply because they work.
Never open an unexpected or strange file attachment. Actually, never open any attachment without first scanning it with an anti-virus/anti-malware application.

M (Message Text): The message text of a phishing email can contain clues that indicate whether it is a legitimate message or a phishing attempt. For example, phishing emails may use urgent or threatening language to encourage users to click on a link or open an attachment. By analyzing the language and tone of the message, the SLAM method can identify these types of phishing attempts and block them.
Overall, by analyzing the sender, links, attachments, and message text of an email, the SLAM method can help identify and block phishing attempts before they can do harm.
Carefully Read the Message (M)
We all do it — scan through messages without reading them fully. Especially in the work environment, where we have hundreds of things to process. Though efficient, this can be unsafe if you come across a phishing email. When scanning the email, you will likely miss small spelling or grammatical errors that can indicate it's a scam. Even reading through the email, these errors can be difficult to spot, because our brains can automatically process words even if they're incorrect. That is why it's important to be thorough in order to catch any potential red flags in the email.
If you don't have time to read the email carefully, don't take any actions (clicking a link or downloading an attachment) until you can [23].

5. Challenges in Phishing Attacks

The main challenge is the difficulty in developing a solid model of what acceptable behaviour is and what an attack is; as a result, they may generate a high number of false positive alarms, which may be caused by atypical behaviour that is actually normal and authorised, because normal behaviour can change easily and quickly. The active application of Artificial Intelligence is not the only challenge that organisations and cyber defence experts must face. Others are the result of flaws in the present security methodology [12].

- Distant infrastructure. Today, systems communicate across continents, sending sensitive data AI over the world. These transfers don't undergo sufficient protection and are easier to break into.
- Manual detection. Human teams don't have 24/7 focus on security threats and suspicious patterns. Most of the time, systems go unmonitored.
- Reactivity of security teams. Most security experts focus on facing threats rather than predicting them.
- Dynamic treats. Hackers have many strategies for hiding their locations, IPs, identities, and methods. The cyber defence field, on the other hand, is a lot more transparent and open for research – data, created by businesses, is easily accessible by criminals.
- An intrusion detection system, no matter how efficient, may be disabled by attackers if they can learn how the system works.
- Another problem involves supplying intrusion detection systems that will conform to legal regulations, security requirements and/or service-level agreements in real world.
- Social engineering tactics. Phishing attacks often use social engineering tactics to trick users into divulging sensitive information or clicking on malicious links. These tactics can be difficult to defend against because they rely on exploiting human psychology and emotions.
- Sophisticated techniques. Phishing attacks can be sophisticated and difficult to detect, with attackers using techniques like spear-phishing or whaling to target specific individuals or organizations. These attacks can be customized to include convincing language, logos, and other elements that make them appear legitimate.
- Use of encryption and obfuscation. Attackers may use encryption and obfuscation techniques to hide malicious payloads or evade detection by security software. This can make it difficult to detect and block phishing attempts before they reach their intended target.

6. The Way Forward in Phishing Detection

It's no wonder that cyber security is a top issue for all organisations, especially at a time when the world is going digital. Phishing detection professionals are hard at work developing innovative solutions to give a comprehensive and effective defence system. It requires considerably more care. Given human limits and the intelligence of agents such as computer viruses and worms, network-centric systems require intelligent cyber sensor agents that detect, evaluate, and respond to cyber threats in a timely manner [23].

With SLAM tools here are few predictions on how it will change (enhance) the cyber defence system?

- Using machine learning and artificial intelligence: By analysing massive amounts of data and discovering patterns and anomalies, machine learning and artificial intelligence can be used to detect phishing attempts. These technologies can aid in the detection of new and developing phishing assaults that standard signature-based detection methods may miss.
- Organisational collaboration and information sharing can help to improve phishing detection and response. Sharing threat intelligence and best practises, as well as working on incident response and remediation activities, can be examples of this.
- User education and awareness: In the fight against phishing attacks, user education and awareness is crucial. To assist users in recognising and avoiding phishing attacks, organisations should provide frequent training and awareness programmes.

Furthermore, much more study is needed before we can build reliable, deployable intelligent agent systems capable of managing distributed infrastructures. In the future, researchers must look for a theory of group utility function that will allow groups of agents to make judgements. It is advised that teams not only look for preventive phishing assaults, but also consult with technology to plan an aftermath [22].

7. Conclusion

Spoofed E-mail detection is regarded as one of the most encouraging advances in the information age and cyber security. The rapid growth of information technology has a significant positive impact and brought many conveniences into our lives. However, it also resulted in difficult-to-manage concerns, such as the advent of

cybercrime. As a result, security execution is improved, and the system is better protected against an increasing number of refined cyber attacks. As technology advances, so do criminal cases. Every day, we see an increase in the number and diversity of cyber crimes, as modern technology makes it easy for criminals to fulfil their objectives.

Organisations anticipate that hackers will begin actively exploiting AI in the near future, and let's face it, standard technologies can't handle such dangers. As it stands, most businesses are unprepared to deal with extremely intelligent viruses, malware, ransomware, and other types of cyber attacks. One thing is certain: implementing some detective and preventive solutions can already help firms spend less time and effort on daily security duties while also better preparing them for emerging hazards. IT is both a weapon against present dangers and a long-term investment. Because technology is becoming more widely available, there will soon be no reason for any organisation to put off using this strategy. Instead than waiting for custom tools to accomplish large-scale security,

This study has briefly reviewed accomplishments made thus far in the field of implementing faked e-mail detection algorithms for preventing cybercrime, their obstacles and desired qualities, as well as the scope to route forward in cyber security.

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Parametric Study of Additive Manufacturing Process in FDM Technology

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Abstract

Additive manufacturing has got wide applications in different industries. Fused Deposition Modelling (FDM) is one of the most widely used additive manufacturing processes in which the part is manufactured by depositing the material layer-by-layer. Additive manufacturing (AM) is capable of producing complex geometries and components using metal, ceramic, and polymer-based materials. FDM Process uses a continuous filament of a thermoplastic polymer to 3D print layer of products. The benefits of this method are that it has low cost and high speed. It is obvious that a select few applications have claimed greater popularity than the rest. These popular areas are biomaterials, aerospace, buildings, and protective structures. In this study, Poly lactic acid (PLA), Polybutylene terephthalate Glycol (PETG), Acrylonitrile butadiene styrene (ABS) are printed in standard specimen at different angles. Input parameters like temperature, speed and raster patterns are varied for different angles of specimen. At the later stage, different material is compared based on mechanical properties and parameters achieved by testing to finalize the material to be used for printing of commercial products.

Keywords: Additive manufacturing, 3D Printing, FDM technology, Parametric Study, 3D printing materials, study of process parameters.

1. Introduction

1.1. Additive manufacturing or with its more popular name 3D printing is a process of creating physical objects from a digital model by fusing materials layer by layer successively with light, heat or chemicals. These digital models can be formed via computer aided design (CAD) programs or 3D scanners. Then, digital model is sliced into layers by software and sent to the 3D printer for execution.[1]. There are a number of different 3D printing methods, yet 3D printers mainly form layers by either squirting the raw material through nozzles onto a build area or selectively fuse liquid, solid or powdered material. While traditional manufacturing techniques like cutting, machining, punching, and grinding are subtractive since they produce final parts by removing some portion of the mass raw material, 3D printing is an additive process as it produces the parts by bonding raw material as needed.[1].

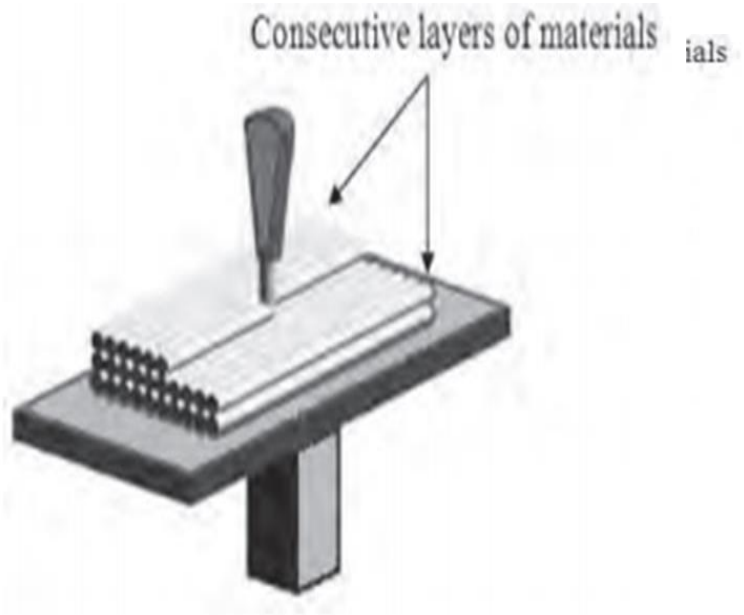

Fig. 1. 3D Printing Process Layer by Layer [1]

1.2. Types of 3D printing process

Solid-based 3D printing: 3D printers that use fused deposition modeling (FDM) produces objects by extruding heated material, usually thermoplastic or metal wire, from a nozzle layer by layer.[1]

Liquid-based 3D printing: in stereolithography (SLA) method, a tank filled with liquid plastic (photopolymer) is used. There is a perforated platform on the top of the tank, and it leaves a thin layer of photopolymer on the surface. [1]

Powder-based 3D printing: selective laser sintering (SLS) works very similarly to SLA except using polymer, metal or ceramic powder instead of liquid plastic. In SLS, laser selectively sinters powdered raw material which is spread as a thin layer on the powder bed. At the end of each cycle, powder bed is lowered incrementally, and a fresh layer of powder is added.[1]

1.3. 3D Printing Applications

1. Desktop 3D printers provide an enormous opportunity for individuals to produce whatever they wish and at their own places, within the dimensions allowed by a desktop 3D printer and raw material possibilities. Hobby items, toys, utensils, ornamental objects are just some of the first examples coming to mind.[1]
2. One of the most amazing examples of 3D printing applications comes from construction sector. Although it is in a very early phase, there have been multiple successful efforts to construct buildings by using gigantic 3D printers. Most popular materials for building printing are plastic, concrete, and sand. If it measures up, building printing may bring about improvements in terms of quality, speed, costs - especially labor costs, flexibility, modularity, work safety, and environmental effects.[1]
3. 3D printing can also be used for other educational purposes, especially regarding science, technology, engineering, and mathematics (STEMS) skills. By utilizing 3D printers, students can design and produce objects in classroom environment and, thus, find a valuable opportunity for testing ideas and learning by doing. This increases fun, teamwork, and interactivity in class as well as supporting creativity, computer skills and three- dimensional thinking ability of students. Thanks to 3D printing, students can see engineering concepts prior to higher education, and university students can comprehend the content of technical courses better.[1]
4. Electronics industry is one of the early adapters of 3D printing technology. 3D printers have been used for production of complex special parts from different materials as well as styling work in this industry. 3D printing is also perfectly suited to the fashion industry, where personalization is critically important. 3D printed custom jewelry and clothes are becoming popular.[1]
5. Aerospace industry is another eager customer of 3D printing technology. Increasing number of aircraft parts, especially those with complex shapes or assembled from different parts, have been produced by 3D printers. This brings about significant advantages regarding tooling, inspection, maintenance, assembly, and inventory. [1]

2. Literature Review

M. Manoj Prabhakar's work investigates the effect of input parameters like filament diameter, extruder temperature, feed rate, raster angle, characteristic of working material, nozzle angle, and distance between parallel faces on output parameters. Some approaches are suggested to maximize these parameters. It is believed a summary of the approaches produced would help compare their major characteristics and their benefits and limitations to help choose one of the most acceptable approaches for a specific application.[3]

Diego bermudez's work, the former 'gold standard', pla grade 4043d, is compared to the newer grade, 3d870. Mechanical properties, rheological characteristics, chemical qualities, and the ability to manipulate the crystallinity of the material were compared between the two. A detailed fracture surface analysis of tensile specimens was also performed that revealed distinct differences in crack propagation behavior between the two materials in the annealed and non-annealed conditions.[4]

Amanuel diriba tura's work presents an experimental examination into the quality analysis of parameters on printed components utilizing fdm. By adjusting process factors such as layer height, raster width, raster angle, and orientation angle, the experiment was carried out utilizing Taguchi's l18 mixed orthogonal array approach. The unitek-94100 universal testing equipment was used to evaluate the flexural strength of acrylonitrile butadiene styrene (abs) specimens that had been conditioned as per astm d790 standard. The impacts of parameters on experimental results were examined and optimized using the hybrid genetic algorithm with response surface methods, response surface approach, and Taguchi method. When the optimal solutions of each technique were studied, the response surface approach and Taguchi methods were determined to be less promising than the genetic algorithm method.[5]

João Francisco's paper aims to determine the influence that some 3D printing parameters (Filling Density, Extrusion Temperature, Raster Angle and Layer Thickness) have in some of the mechanical properties (Ultimate Tensile Strength, Yield Tensile Strength, Modulus of Elasticity, Elongation at Break and Toughness) of PLA, after it goes through the printing process. It is also the aim to find the scale of the amount of water that it's absorbed by the PLA and find a way to reduce this absorption. It was also found o3ut that for each parameter value, each mechanical property reacts differently.[6]

Mohammed Hikmat's paper experimentally and statistically studied the effect of various printing parameters namely build orientation, raster orientation, nozzle diameter, extruder temperature, infill density, shell number, and extruding speed on tensile strength using Polylactic acid (PLA) filament. the specimens of PLA are printed on an FDM 3D printer and tested for tensile strength using the universal testing machine. the confirmation test showed that there is a good agreement between the experimental and statistical data.[7]

3.Design and development of 3D printed sample

3.1. Design

For Testing the material according to 3D Printing process parameters one design is required. Following design is as per the ASTM D-638 Standard. Also, the dimension of design is 165 x 10 x 3.2 mm which can easily print on small size of printer which is easily available in market. The test specimens were designed to conform to ASTM D-638, standard test method for tensile testing of plastics, as illustrated in figure 2. [2]

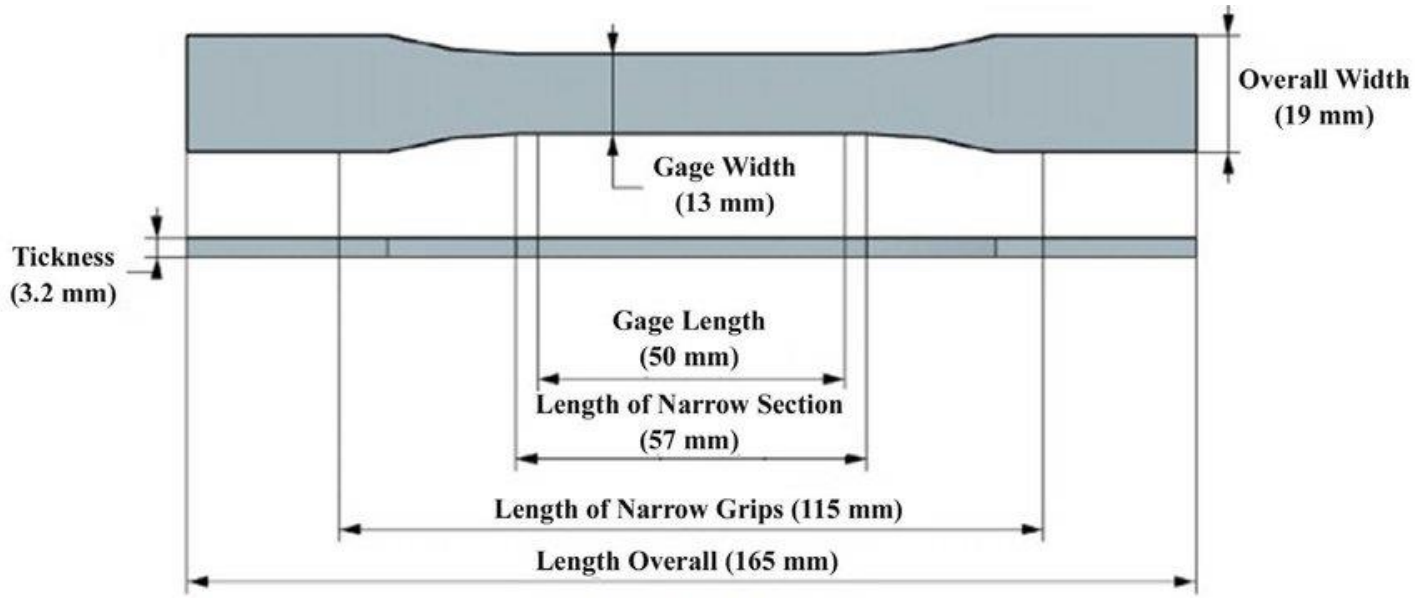

Fig. 2. Design of specimen as per ASTM D638[2]

3.2. Inputs for Sample printing varying process parameters

To test more precisely, total 18 number of samples is taken with 5 parameters which is material, raster pattern, infill geometry, extruder temperature & layer Hight. These parameters can be affected directly on the results.

Table 1. Process Parameters

Sample No.	Material	Raster Pattern	Infill Geometry (%)	Extruder Temperature (°C)	Layer Hight (mm)
1	ABS	(Line)	60	230	0.2
2			80	220	0.3
3		(Triangle)	60	230	0.2

4			80	220	0.3
5		(Grid)	60	230	0.2
6			80	220	0.3
7	PLA+	(Line)	60	190	0.2
8			80	220	0.3
9		(Triangle)	60	190	0.2
10			80	220	0.3
11		(Grid)	60	190	0.2
12			80	220	0.3
13	PETG	(Line)	60	220	0.2
14			80	240	0.3
15		(Triangle)	60	220	0.2
16			80	240	0.3
17		(Grid)	60	220	0.2
18			80	240	0.3

4.Results & Discussions

4.1. Result of Tensile Test

Tensile test is done on UTS machine at Hertz Testing and Training Center, Vatva GIDC. 6 sample is tested on UTS Machine by applying tensile load on it.

Table 2. Result of actual tensile test of sample

Sample No.	Material	Load (KN)	CHT (mm/min)
1	ABS	0.616	3
2	ABS	0.727	3
7	PLA+	1.025	3
8	PLA+	1.331	3
13	PETG	0.925	3
14	PETG	1.284	3

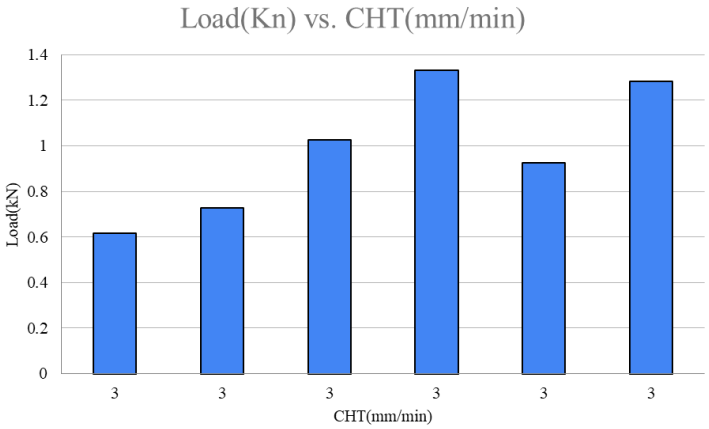

Fig. 3. Graph of Load vs. CHT rate

4.2. Result of Bending Test

UTS machine has limited load applying capacity. It is hard to perform bending test of plastic on UTS Machine.so, to do bending test of specimen CAD software is used to get proper precise results. Line and point loads are applied in software called Creo parametric 4.0 by which the following result is obtained.

Table 3. Result of graphical bending test of smaples

Sr. No	Material	Location of load	Load (KN)	Point Load (Mpa)	Line Load (Mpa)
1	ABS	Centre	0.00071383	0.58525	0.60146
2	ABS	Griping Part	0.00071383	0.50017	0.50160
3	ABS	Side	0.00071383	3.70895	3.70895
4	PLA+	Centre	0.00087545	0.71862	0.74038
5	PLA+	Griping Part	0.00087545	0.60320	0.60479
6	PLA+	Side	0.00087545	4.55420	4.55420

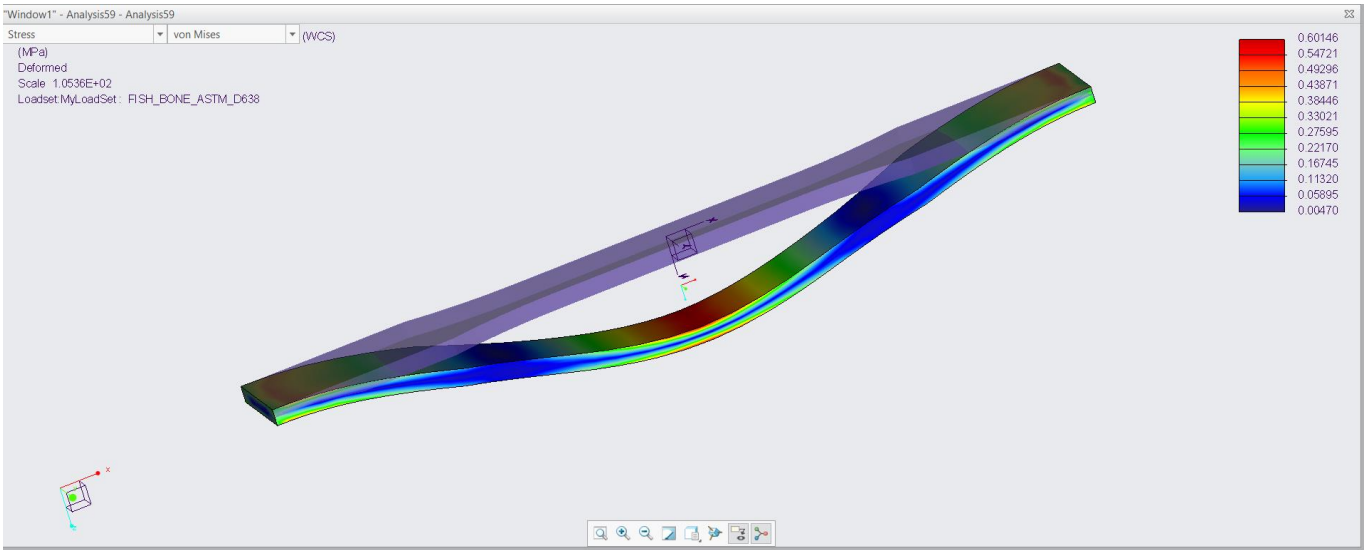

Fig. 4. Sample no.1

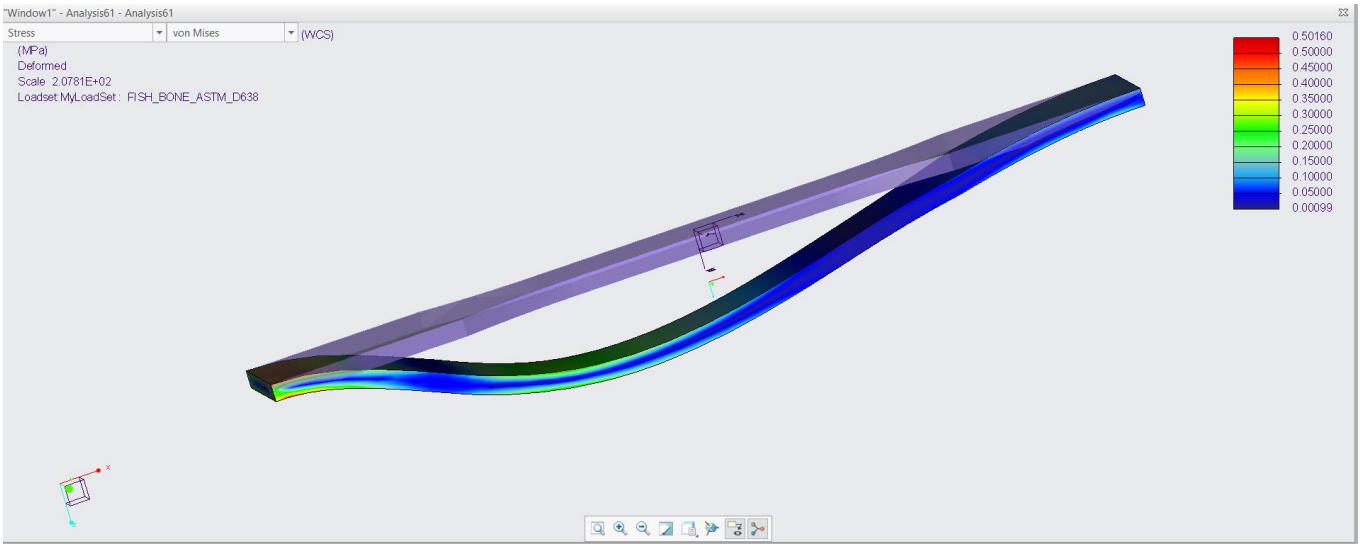

Fig. 5. Sample no.2

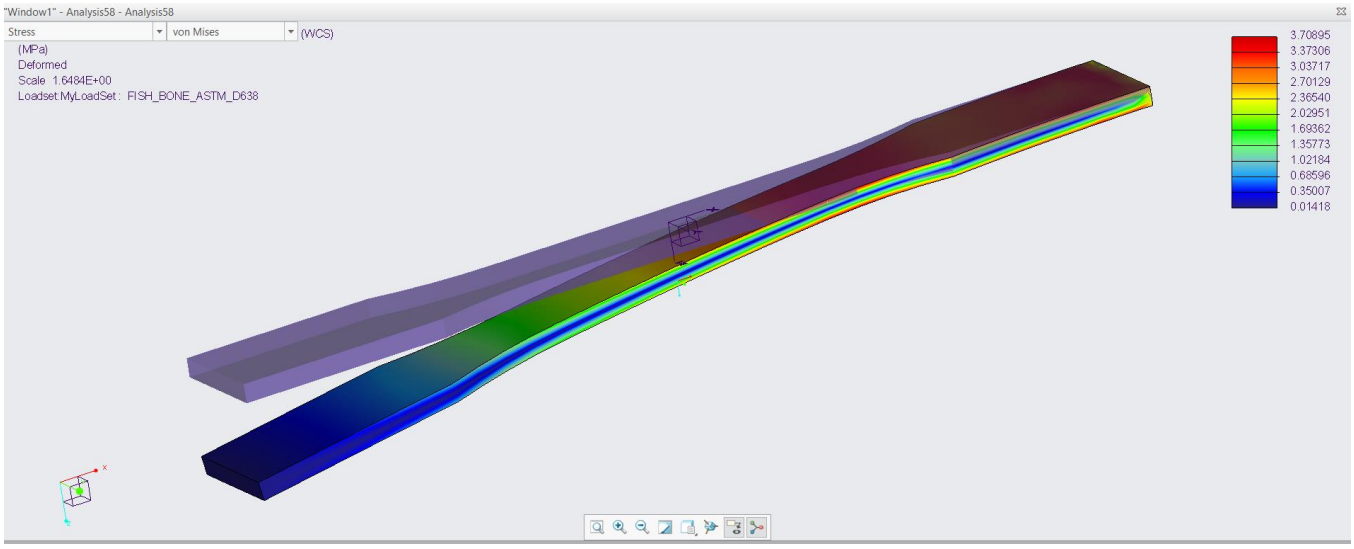

Fig. 6. Sample no.3

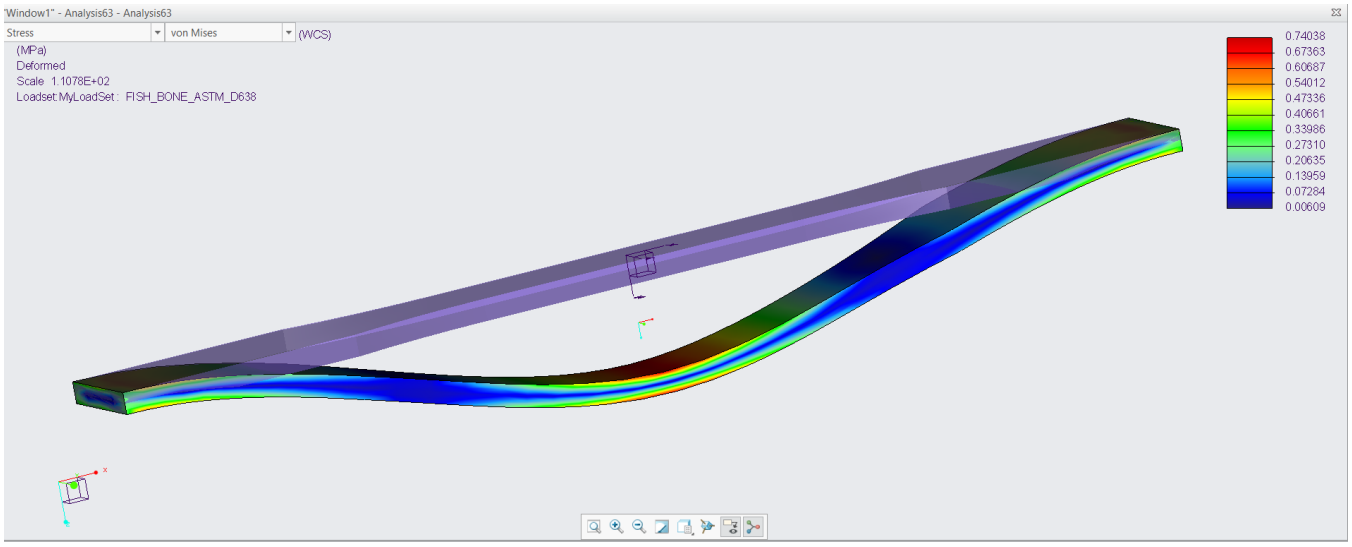

Fig. 7. Sample no.4

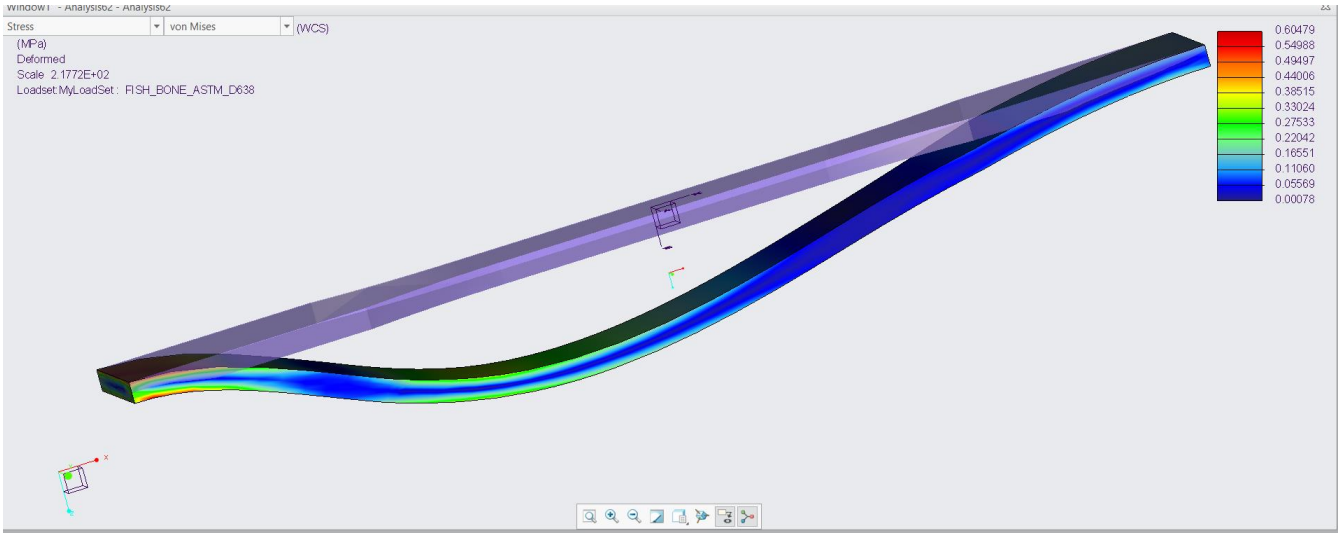

Fig. 8. Sample no.5

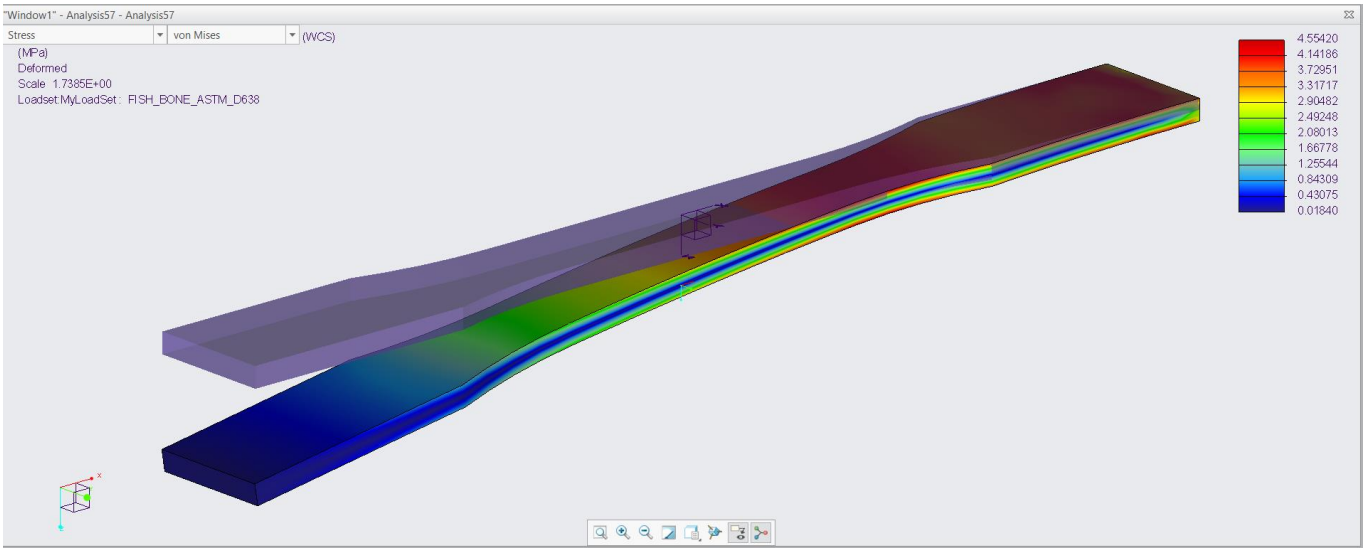

Fig. 9. Sample no.6

4.3. Summary of Results

As per the results PLA+ material has higher stress sustain capacity showed in Figure 9. in that figure side load has applied on the sample and one end is fixed. The same method is applied on figure 6 and material is ABS. the different between stress sustaining capacity of both the material is very less. But by considering the other properties of material, ABS is Better than PLA+.

4.4. Problem Definition

Now day's technology needs smart gadgets and smart gadgets needs proper handling. Router is one of the known smart gadgets. And it needs proper stand to mount it on wall. But the router stands which is available in market has not suitable material. Which is wooden, fiber & plastic. Also, the material which used in market has lower mechanical properties. Like lower strength & load caring capacity. Design is also not that much effective; all the router stands are wall mounted which can be mounted by screw. Screw halls can damage walls. Which is also not suitable for wall. Also, all the router stand are consuming space of 5-8 inch in room. Design of router stand is also not suitable in aesthetic and agronomical way.

4.5. Design of Router Stand

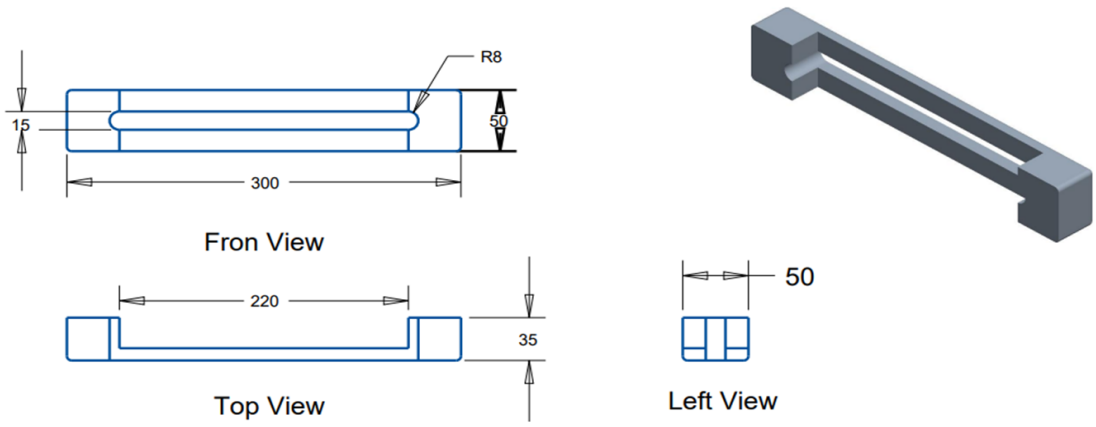

Fig. 10. Fixed Router Stand

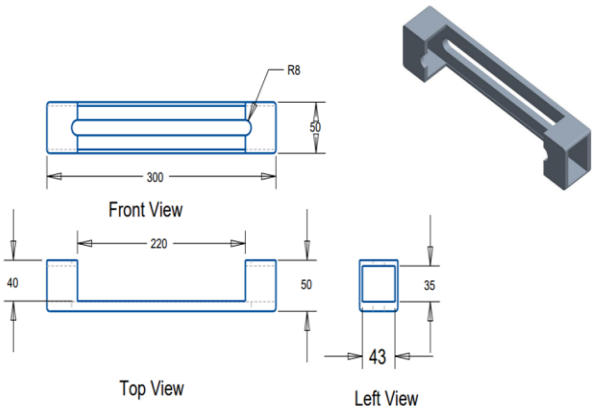

Fig. 11. Fixed Part of Assemble Router

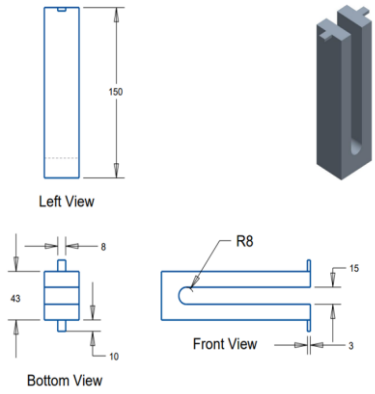

Fig. 12. Moving Part of Assemble Router

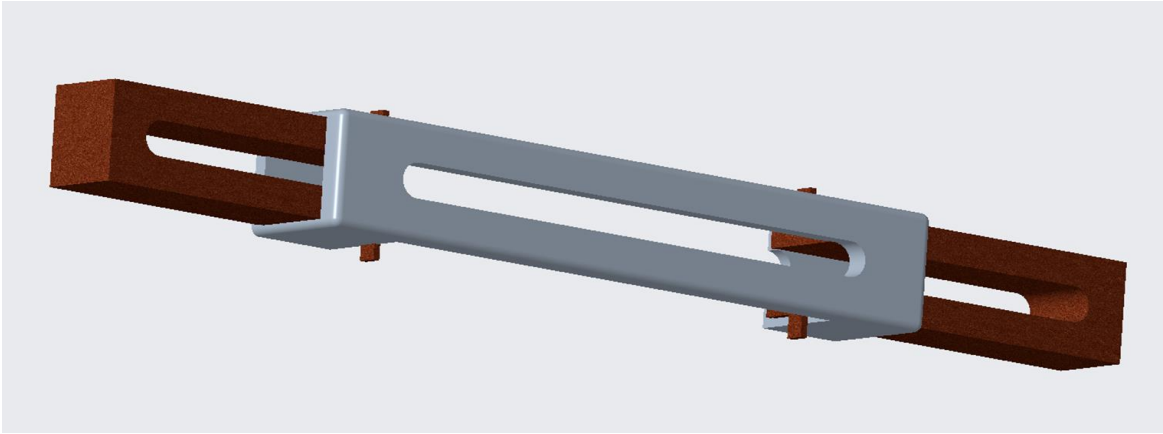

Fig. 13. Assembled Router

4.6. Conclusion

In this work, research demonstrates that the strength of parts manufactured through FDM is significantly affected by important printing parameters. An effort has been made in the present work to assess the effect of mentioned parameters on the mechanical properties of the printed parts. changing in mentioned parameters can be directly affect the mechanical properties of 3D printing materials. Also, it's observed that Abs has better mechanical properties than Pla. Which can be good effective material for printing of router stand & other commercial products. type of load and location of load is affecting the stress of 3D printed material.

Layer hight is playing good role in increasing of strength of material. After that raster pattern and infill geometry is also affecting the strength of material. Changing in infill geometry, extruder temperature, layer height, raster pattern, type of load and location of load can optimize the final 3D printed product.

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Comparing Image Recognition Algorithms in Artificial Intelligence

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Abstract

Image Recognition is a crucial component of artificial intelligence which finds many applications in fields from the self-driving car to the detection and diagnosis of diseases. Different Algorithms have been developed to give high accuracy and effectiveness in image recognition. Each has its strengths and weaknesses. This paper compares the most widely used algorithms, including convolutional neural networks (CNNs), decision trees, k nearest neighbors (KNN), support vector machines (SVMs) and random forests. The comparison is based on their accuracy, training and testing time and performance on standard image recognition datasets. Our analysis reveals that CNNs are the most favourable algorithm for image recognition due to their high accuracy and their capability to learn complex features from images. Overall, this paper delivers insights into the performance and practicality of different image recognition algorithms and can serve as a valuable resource for researchers and practitioners in the field of artificial intelligence.

Keywords: Image Recognition; Convolutional neural network; Random forests; Support vector machines; K nearest neighbors

1. Introduction

Image recognition is one of the most important and popular applications of artificial intelligence (AI). Image recognition is the process of identifying and detecting objects, patterns, or features in digital images. It involves using computer algorithms and techniques to analyze the visual content of an image and make sense of it. Image Recognition finds its application in many fields like Object recognition, Autonomous vehicles, Security, Entertainment, Agriculture, Medical diagnosis, Face recognition and Environmental monitoring. For example, in healthcare, image recognition can be used to diagnose diseases and detect abnormalities in medical images such as X-rays and MRI scans. In security, image recognition can be used to identify individuals and track their movements in surveillance footage. In manufacturing, image recognition can be used to inspect products for defects and ensure quality control. In agriculture, it can be used to monitor crops and yield prediction. It can help farmers detect diseases and pests, track plant growth, and optimize harvests. In the entertainment industry, it can be for video and image analysis. It can help identify copyright violations, monitor content for inappropriate material, and provide personalized recommendations to users. As technology is evolving, we can expect to see even more innovative and impactful uses emerge in the coming years. Image recognition systems typically work by analyzing the features of an image and comparing them to known patterns or templates. This is done using complex algorithms that are designed to identify specific features or characteristics of an object or scene, such as shape, color, texture, and spatial arrangement. These algorithms can be trained using large datasets of labeled images, allowing them to recognize patterns and make accurate predictions about new images.

Image Recognition is one of the important and old problems in artificial intelligence. It is a challenging task to detect objects from the image [1]. The capability to accurately identify and classify the objects in the image has been a problem for researchers. AI has made this difficult task possible by making devices as intelligent as humans to recognize patterns in different conditions [2]. There are many image classification algorithms where the most commonly used are machine learning algorithms and deep learning algorithms [3]. The process of Deep learning includes self-learning by building a multilayer model and training it with large amounts of data. It helps in improving the accuracy rate and performance of the classification or prediction [4]. The image recognition process based on deep learning mainly gives the image into the neural network. Then it uses the deep learning forward propagation and backpropagation error algorithms so that it can minimize the loss of input function [5]. Here, several machine learning and deep learning algorithms are selected such as convolutional neural networks (CNNs), support vector machines (SVM), k nearest neighbors (KNN), decision trees and random forests.

Artificial Neural Network (ANN) has been studied for many years to solve complex classification problems including image classification [6]. One advantage of artificial neural networks is that the algorithm could be generalized to use in different kinds of situations using the same designs [7]. Convolutional Neural Networks (CNNs) are a class of deep learning neural networks that are generally used for image recognition tasks. CNNs are designed to learn spatial orders of features from input data, such as

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images, on their own without the need for manual feature extraction [8]. CNN can learn the local and global structures from image data effectively. SVM is a mathematical extension of Neural Network, and it performs classification by converting the original training data into multidimensional space and constructing hyper-plane in higher dimensional [9]. Decision Trees are a class of supervised machine learning algorithms used for classification [10]. The effectiveness of Decision Tree algorithms is that they provide rules of classification which are easily understandable [11]. It has some drawbacks too, one of them is when the tree chooses to split a node, the sorting of all numerical attributes is required. It can become costly if Decision Trees are set on the larger size of data i.e. it has more instances [12]. KNN classification algorithms determine the class of an image by looking for the k images of the training set which are most similar to the image to be classified, and then it performs a class-weighted frequency analysis [13]. A random forest, a combination of decision trees, is constructed by randomly selecting trees from a set of possible trees, where each tree is trained on a random subset of input data and features [14]. Random trees can be created effectively and the collection of large sets of random trees commonly leads to accurate models. There has been comprehensive research on Random trees in current years [12]. These algorithms are compared based on their precision, recall, f1 score, accuracy, and speed.

2. Methodology

2.1. Model Diagram:

Here, First the data has been taken from dataset then after pre-processing, we separated it into two parts, training set and testing set. The data in training set was trained using different algorithms. Then testing conducted on the testing set and it gave results which helps us to evaluate the performance and accuracy of an algorithm. The following figure shows the flow of process conducted in constructing the model.

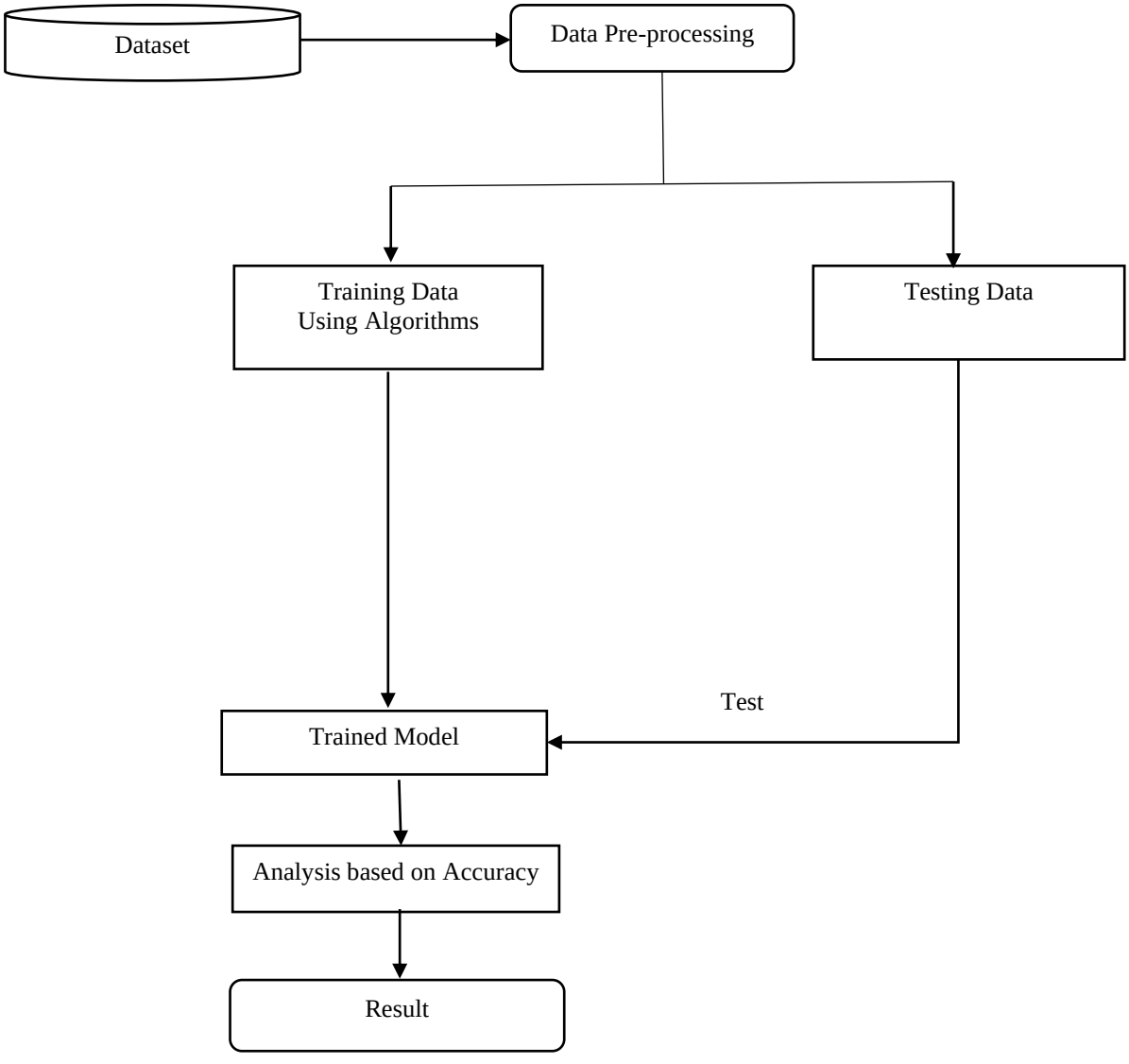

Fig. 1. Illustration of process flow of model

2.2. Dataset Used:

For this work, the MNIST dataset is used for an image classification task. It consists of a collection of 70,000 handwritten digits (0-9) that have been normalized and centered in a fixed-size image of 28x28 pixels. The dataset is commonly used as a standard for training and evaluating machine learning models. The dataset is divided into two sets: a training set of 60,000 images and a test set of 10,000 images. The goal of the MNIST dataset is to classify the digits correctly based on their pixel values. Each image is represented as a 784-dimensional vector, where each element represents the grayscale value of a single pixel. The task is to train a machine learning model on the training set to predict the correct label of each digit in the test set.

2.3 Algorithms Used:

2.3.1. Convolutional Neural Network (CNN):

In recent years, CNN finds its application in many fields such as face recognition, speech recognition [15], natural language analysis [16], brain wave analysis [17], [5]. The convolutional neural network is a type of artificial neural network used as a deep learning algorithm which is designed to process inputs like images and videos. CNN is composed of several layers of processing, including convolutional layers, pooling layers, and fully connected layers [18]. A convolutional model takes input images and convolves them with kernels to extract features of the image [3]. The result of the convolution operation is a single number that shows the degree of similarity between the filter and the input region. The pooling layer reduces the spatial dimensions of the feature maps and makes them more manageable for the following layers. The fully connected layer performs a classification or regression task based on the features extracted by the earlier layers.

2.3.2 Support Vector Machines (SVM):

Support Vector Machine is a supervised machine learning algorithm which is used for classification and regression analysis. The SVM algorithm works by finding the optimal hyperplane that splits the data into different types. The hyperplane is selected in such a way that it maximizes the distance between the closest data points of different classes, which are called support vectors [19]. This hyperplane is called the Optimal Separating Hyperplane whose task is to minimize the risk of misclassifying the examples in the training set as well as the unseen examples of the test set [20].

*2.3.3 Decision tree***:**

Decision trees are commonly used supervised machine learning algorithms that are used for both classification and regression. Decision trees consist of nodes. At each node, the algorithm picks the feature or attribute that provides the most information gain to divide the data into the different classes. The decision tree is built by selecting the best attribute to separate the data at each node until all the data points are correctly classified.

2.3.4 K nearest neighbors (KNN):

The k-nearest neighbor algorithm is the simplest algorithm out of all machine learning algorithms. The algorithm works by finding the k closest data points in the training set. The algorithm works by finding the distance between the input data point and every other data point in the training set, using a distance metric such as Euclidean distance or Manhattan distance. The k closest data points, also known as the nearest neighbors, are then used to determine the predicted label of the input data point [21]. KNN is an easy-to-understand algorithm that can be used for both classification and regression tasks.

2.3.5 Random Forests:

A random forest is a popular decision tree ensemble learning algorithm used in machine learning for classification and regression tasks. It means that it combines multiple weaker models to create a more powerful and accurate model. In the random forest algorithm, each tree grows with some type of randomization [22]. This algorithm creates a forest of decision trees. Each tree will be trained on a random subset of training data and features. At the time of prediction, each tree in the forest is used to make a prediction and the final prediction is determined by aggregating the predictions of all the trees.

3. Evaluation

The evaluation is done based on various factors such as confusion matrix, precision, f1 score and recall. A confusion matrix is used to show the number of correct and incorrect predictions made by the model. It consists of dime dimensions: predicted class and actual class. It has four possible outcomes: True Positive (TP) which means the prediction is correct, and False Positive (FP) which means the model predicted a positive class but the prediction is incorrect. Then we have True Negative (TN) which means the model predicted a negative class with a correct prediction, and False Negative (FN) where the model predicted a negative clas s with an incorrect prediction. Precision, recall and F1 score are the parts of the classification report which help to evaluate the per formance of the model. Precision is a measure which calculates the percent of correctly identified positive cases out of all positive cases identified by a model. Precision can be given as:

$$Precision = \frac{TP}{(TP + FP)} \tag{1}$$

Recall is a measure that calculates percent of correctly out of all the actual positive cases that exist in a population. Recall can be expresses as follows:

$$Recall = \frac{TP}{(TP + FN)} \tag{2}$$

F1 score is a measure that combines precision and recall into a single metric. The F1 score is a harmonic mean of precision and recall and is expressed as below:

$$F1 = \frac{2 * Precision * Recall}{(Precision + Recall)} \tag{3}$$

4. Result

The classification report for different algorithms is shown as from table 1 to table 5. The classification report contains the Precision, recall and f1 score of the algorithm.

Table 1: Classification report of CNN

	precision	recall	f1 score
0	0.98	0.99	0.98
1	0.99	1.00	0.99
2	0.98	0.98	0.98
3	0.98	0.99	0.98
4	0.98	0.99	0.98
5	0.99	0.97	0.98
6	0.98	0.99	0.98
7	0.98	0.98	0.98
8	0.99	0.95	0.97
9	0.98	0.98	0.98

Table 2: Classification report of SVM

	precision	recall	f1 score
0	0.95	0.98	0.96
1	0.97	0.99	0.98
2	0.92	0.94	0.93
3	0.91	0.93	0.92
4	0.93	0.96	0.94
5	0.91	0.89	0.90
6	0.96	0.95	0.95
7	0.95	0.93	0.94
8	0.93	0.90	0.91
9	0.95	0.92	0.93

Table 3: Classification report of Decision trees

	precision	recall	f1 score
0	0.91	0.94	0.93
1	0.96	0.96	0.96
2	0.87	0.86	0.86
3	0.83	0.85	0.84
4	0.87	0.88	0.87
5	0.84	0.83	0.84
6	0.90	0.89	0.89
7	0.92	0.90	0.91
8	0.82	0.81	0.82
9	0.85	0.85	0.85

Table 4: Classification report of KNN

	precision	recall	f1 score
0	0.98	0.99	0.99
1	0.96	1.00	0.98
2	0.98	0.96	0.97
3	0.96	0.96	0.96
4	0.97	0.96	0.97
5	0.95	0.96	0.95
6	0.98	0.99	0.98
7	0.96	0.97	0.96
8	0.98	0.94	0.96
9	0.95	0.95	0.95

Table 5: Classification report of Random forests

	precision	recall	f1 score
0	0.97	0.99	0.98
1	0.99	0.99	0.99
2	0.97	0.97	0.97
3	0.96	0.96	0.96
4	0.97	0.98	0.98
5	0.98	0.96	0.97
6	0.97	0.98	0.98
7	0.97	0.96	0.97
8	0.96	0.96	0.96
9	0.96	0.96	0.96

From the above data, it is clear that convolutional neural network algorithm is showing maximum precision for all the classes. Also, it is the algorithm with maximum recall value for all the classes. CNN's f1 score is highest and consistent among all the clas ses as compared to other algorithms. Accuracy of different algorithms are shown in the table 6. Accuracy of an algorithm can be c alculated as follows:

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN} \tag{4}$$

From table 6, it is analysed that Convolutional neural networks showing the maximum accuracy. So, we can say that CNN can recognize and classify the images with more accuracy than any other algorithms.

Table 6. Performance of Algorithms

Algorithms	Accuracy %
Convolutional neural networks (CNN)	98.00
Support Vector Machines (SVM)	94.00
Decision Tress	88.00
K nearest neighbour (KNN)	97.00
Random Forest	97.00

5. Conclusion

In conclusion, the comparison of different algorithms for image recognition is an important area of research that can provide valuable insights into the strengths and weaknesses of different approaches. We have reviewed and compared several popular algorithms for image recognition, including convolutional neural networks (CNNs), support vector machines (SVMs), and k-nearest neighbors (KNNs), decision trees and random forests. The finding of this paper indicates that Convolutional neural networks are an effective deep learning algorithm for image recognition. This paper has compared different image recognition algorithms to evaluate their performance based on accuracy, precision, recall and f1 score. Our analysis has shown that CNN is currently the most effective algorithm for image recognition as it has achieved high accuracy and speed on a standard dataset. However, SVMs and KNNs can also be effective for certain types of image recognition tasks, such as object recognition and image segmentation. Other factors, such as the size and quality of the training dataset, the complexity of the image features, and the computational resources available, can also impact the performance of different algorithms. It is important to note that the performance of each algorithm depends on the quality and complexity of the image. The study underscores the potential of image recognition technologies to drive innovation and create new opportunities in various industries.

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Balancing Latency and Energy Efficiency in Wireless Sensor Networks: A Comparative Study

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Abstract

Along with poor processing and storage capacity, each sensor in wireless sensor network (WSN) is equipped with a limited energy resource and difficult to be replaced in most application environments. However, the designs for wireless sensor networks focus on not only energy-efficiency issues but also other problems such as fault tolerance, scalability, latency, and network topology. In this paper, we mainly focus on balancing latency and energy-efficiency as primary design objectives of routing protocols for WSNs. Our presentation is accompanied by analysis of the current state-of-the-art of routing techniques for optimizing energy-efficiency interested in latency factor. Furthermore, we propose a new research direction to balance energy-efficiency and latency in WSNs.

Keywords: sensor network, energy efficiency, latency, balance, routing.

1. INTRODUCTION

With the rapid development of science and technology, especially in wireless communications technology and embedded device technology, the capacity of the sensors is being significantly improved while their cost is lower. And so, the wireless sensor network (Fig.1) – may be composed of hundreds to thousands of sensors – has more opportunities to be deployed in real environments.

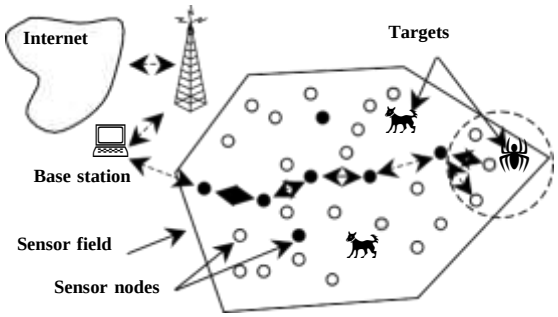

Fig. 1. Communication architecture of a wireless sensor network

The sensor nodes are designed very special to match the dense and random distribution in environment. Along with poor processing and storing, each sensor is equipped with a limited energy resource and difficult to be replaced in most application environments. Therefore, when designing a WSN protocol, we are always interested in energy efficiency. However, when researchers try to reduce energy consumption of the sensors, it causes negative effects to other factors. These factors include latency, reliability, bandwidth, etc.

In many current applications, data should be transmitted from source to destination within a limited period (ie, a real event should be recorded and transmitted to the processing center before a predetermined timeline). If it exceeds this timeline, the data will not be useful anymore. For instance, in fire-alarm applications, if data about the current temperature in the forest is received too late by the monitoring center, the fact that forest had fired while the checkpoints had not received the necessary data. Another example, the application of monitoring the health of patients, all the information about patients must be transmitted on the doctor's clinic for a predetermined time, so that the doctor can offer appropriate and timely treatment. Thus, the networklatency is very important in many WSN applications.

Although heuristic solutions have been presented to balance latency and energy consumption in WSNs, their effectiveness is negligible because of their convergence [1]. In addition, numerous studies based on gene technology [2] and Fuzzy Logic techniques.

[3] have been proposed, but they are still limited for complexity of algorithm. Many multi-path routing algorithms have been introduced to guarantee the network latency but reducing energy efficiency [4]. Grid-based solutions [5], [6] are also suggested,

but they are limited because of their unrealistic assumptions.

Clustering is one technique used very effectively to archive the energy efficiency in WSNs [7], [8], [9], [10]. However, its main drawback is the high latency. Meanwhile, the multi-objective optimization method [11], [12] has been applied to solve optimization problems in many different domains, but the applying it to sovle problems in WSN is not worth considering. Recently, swarm-based methods (inspired by searching for food or way of the natural creatures such as bees, ants or bats, etc.) offer many advantages compared to traditional methods. For example, Artificial Bee Colony (ABC) [13], [14] is the meta-heuristic search method, it is based on inspiration from searching honey of bee colonies in order to find out the optimal solution. Combining this method with clustering techniques will help achieve energy efficiency while maintaining the latency. This will prolong the network lifetime and reduce network latency as well as improve network performance.

Various routing techniques for WSNs are discussed and compared in this paper. In Section II, current state-of-the-art of latency-aware energy-efficient routing techniques for WSNs is surveyed and categorized with a discussion on the advantages, limitations, and performance issues of each technique. Section III identifies research proposals. Finally, concluding remarks are given in section IV.

2. LATENCY-AWARE ENERGY-EFFICIENT TECHNIQUES: COMPARATIVE ANALYSIS

In this section, we classify, highlight key features and discuss the limitations of the energy-efficient routing techniques interested in latency in WSNs. A broad classification of different latency-aware energy- efficient routing techniques for WSNs is shown in Fig. 2 where the numbers indicate the references.

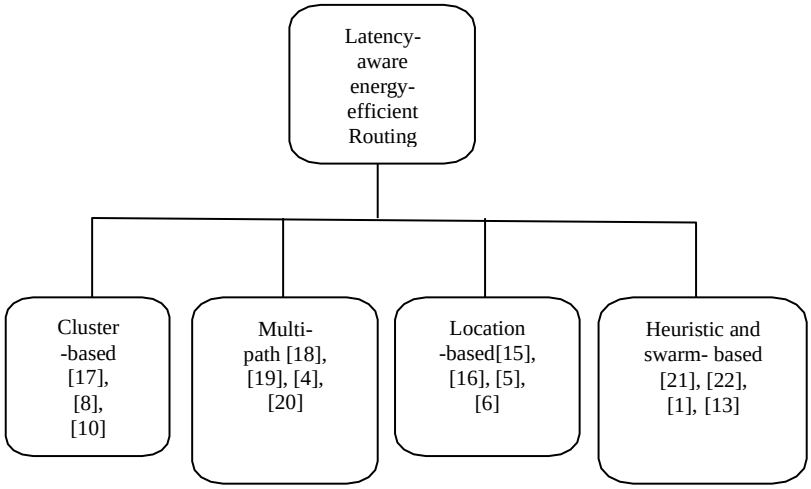

Fig. 2. Classification of Latency-ware energy-efficient routing Techniques in WSNs

2.1 Location-based Routing

SPEED [15] was proposed by T. He guarantees network latency in real-time applications. Accordingly, it requires each sensor to maintain information about adjacent nodes and routing techniques are based on geographic location of sensor nodes. To ensure the network latency, SPEED offers a method which controls speed of packet forwarding in network by dividing the distance from sensor nodes to sink in terms of the speed of the packet before deciding what route the packet will transfer. In addition, this protocol also provides the ability to avoid congestion when the network is congested. Accordingly, the authors provide a routing solution called Stateless Geographic Non-Deterministic (SNFG). As shown in Fig. 3, the latency estimation at each node is based on calculating ACK response time from neighboring nodes. Based on this latency, SNFG will select the node that matches the required speed. Simulation result shows that this protocol reduces the network latency, but the total energy consumed by communication cost is more expensive (due to the simplicity of the routing algorithm and more overheads).

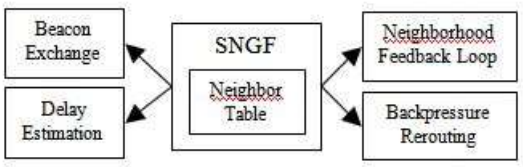

Fig. 3. SNFG Module

RPAR (Real-time Power-Aware Routing) [16] ensures the network latency for some types of the specific applications with low energy consumption by flexible adjusting transmission power and routing decisions based on network load and the timeline values on the packet. Another highlight of RPAR is that it calculates value of average quality links for path deciding in the routing strategy. Employing the local information and neighbor nodes management scheme, RPAR increases network scalability and prolongs the lifetime of network while guarantees the latency. However, routing decision algorithm is quit complex, this make the timeline values higher abnormally and sudden congestion.

Hayoung Oh *et al.* [5] presented a sensor routing scheme called EESR (Energy-Efficient Sensor Routing) that provides energy-efficient data delivery from sensor nodes to the base station (BS). The proposed scheme divides the area into sectors and determines a manager node to each sector. The manager node (1) receives data sent from sensor nodes in its sector, (2) aggregates the received data, and then (3) transfers the aggregated data to the BS through the shortest path of the 2-dimensional (x, y) coordinates. The shortest path selection algorithm is based on the relative direction information of each sensor node from the BS. Performance results show that EESR reduces energy consumption significantly and performs well in terms of low latency and high

scalability. However, assumption that the BS is located at the coordinate center of the network and manager nodes are located in some predetermined position is unrealistic.

In order to reduce the number of relay nodes between the source node and the BS, H. Kajikawa *et al.* [6] proposed a grid-based routing protocol which divides the network area for square cells by using cell rotating technique. As shown in Fig. 4, each cell is divided into multiple sub-cells, and assumes one or two sub-cells to be active-cells. Then, it demarcates the existing area of active nodes to each active-cell. By demarcating the area where the existing area of the active node in each cell, the side length of square cells can be enlarged. In addition, the large cells are divided into the smaller cells; this protocol reduces the number of relay nodes between the source node and the BS as well as reduces the data packets delivery latency and the energy consumption. However, the main drawback of this scheme is that each data source has overhead to exactly compute their location using unique geographical coordinates and proactively build a grid structure.

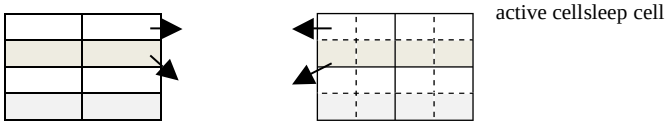

Fig. 4. Cell division methods

2.2 Cluster-based Routing

T.T Huynh *et al.* [17] proposed a new multi-hop routing scheme to balance the efficiency on energy and network delay as shown in Fig. 5.

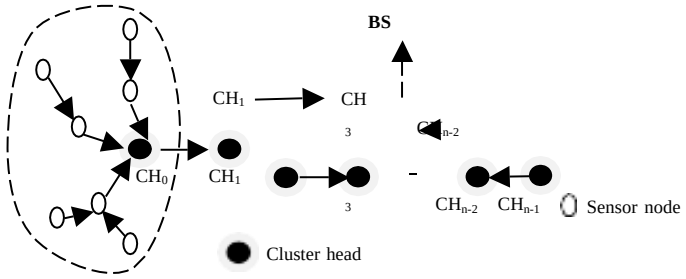

Fig. 5. A combination of cluster and chain scheme

Besides, authors proposed the passive BS-based approach to reduce the high communication overhead compared with general BS-based approach. Authors also proposed two algorithms in order to balance energy and delay metrics for all sensor nodes and extend network lifetime. Energy-Delay routing algorithm is applied within 3-hop cluster for sensors within each cluster while energy-efficient chain construction algorithm is applied for cluster-heads to construct energy-efficient chains from cluster-heads.to the BS. However, the disadvantage of this protocol is that it shows the complexity of routing algorithms and costs for setting up the chains.

A. Allirani et al. proposed Energy Sorting Protocol (ESP) architecture [8] to archive low energy consumption and network latency. The ESP obtains the objective by employing numerous techniques such as the randomized and self-configuring cluster formation, localized control for data transfers and data aggregation. These techniques permit each sensor node to make autonomous decisions to generate good clusters and reduce the number of delivering data in the entire network. However, it makes the overhead to find the cluster- head as well as carries out cluster formation every time. In addition, cluster-heads communicating directly with the BS is not practical. Moreover, data aggregation reduces the

amount of sent data but time-consuming. In fact, it only reduces the setup latency but is not guaranteed in terms of network latency.

Clu-DDAS [10] was proposed by Y. Li et al., which presents an energy-efficient distributed scheduling algorithm based on a cluster-based aggregation tree. Authors studied the well-known Minimum-Latency Aggregation Schedule problem to propose a collision free transmission schedule of data aggregation for all sensors such that the total time latency for aggregated data to reach the sink is minimized. By constructing a Cluster-based Data Aggregation Tree, this protocol permits the packet transmissions among different clusters to be concurrent and conflicting free. This can reduce the network latency. However, constructing distributed trees using broadcasting technique generates more overheads. In addition, the cluster-head performing more processing to aggregate data leads to more changes in the function of the nodes. This makes the distributed tree setup phase occur more frequently, leading to energy and latency efficiency is significantly reduced in random distribution networks.

2.3 Multi-path Routing

EAQoS (Energy Aware QoS) [18] was proposed to find the path with the lowest cost in terms of energy efficiency while meeting the network latency in WSNs. For calculating the link cost, the authors provide a mathematical function with the input parameters including energy level of sensor nodes, the data transferring energy for each node, error rate and some other communication parameters. In addition, to support both best effort traffic and real- time at the same time, a queue model is proposed (Fig. 6). To find a list of the lowest cost path, the author offers an improved Dijkstra algorithm taking the network latency into account. The main weakness of EAQoS is the initialization of the sensor nodes with the same bandwidth reduces the adaptive bandwidth sharing between different network links. In addition, in order to calculate the link costs in Dijkstra algorithm, it requires each sensor node must have knowledge of the entire network, which limits the practicality and network scalability.

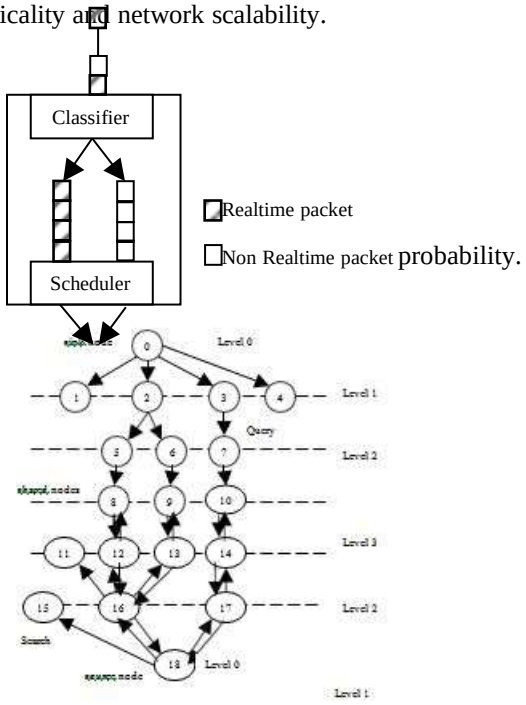

Fig. 6. Queue model in EAQoS

Multi-path and Multi-SPEED (MMSPEED) [19] is the routing protocol supporting various parameters of different constraints by providing distribution packets technique with many different priorities. Accordingly, the packet forwarding technique is based on the probability distribution function in order to control the path of the packets. In this model, each sensor node calculates the transition probability values of neighboring nodes to destination node based on the packet loss rate. Then, each node can send multiple copies of packets to a group of selected adjacent nodes in the set of its neighbors to achieve reliability using the calculated probability values. Although MMSPEED saves on the energy consumption by removing the flooding technique, but it is not interested in the energy level of each sensor node and causes the imbalance of the energy distribution among sensor nodes. Furthermore, this protocol does not use the information on the number of hops that the packet goes through to calculate the value of priorities while taking this information into account to evaluate the level of priority will be more accurate and practical than information about the distance from the source node to destination node.

Liming He proposed a multi-path routing [4], which can discover multiple path with short latency and low overhead. Author proposed two algorithms in order to construct Double Routing Trees (query tree and search tree, Fig. 7) and

discover route from source nodes to sink. This algorithm is effective in terms of energy consumption but only really effective in the applications based on Query-Driven model. In addition, the path updating is not done in packet delivery duration (only done at route discovery Fig. 7. An example of the double routing trees.

DEAR (Delay-bounded Adaptive Energy-constrained Routing) [20] is another multi-path routing protocol. It is interested in many service quality factors such as reliability, latency and energy consumption. As the other multi-path routing methods, this protocol allows packets are continuously distributed across the network even if the paths are going to crash (turning to other paths). Highlights in this protocol are that it allows balance the latency between the different paths by providing a polynomial-time algorithm for solving multi-objective optimization. The main drawback of this protocol is that the energy saving is not worth considering but the complexity of the algorithm is quite considering. This decreases the efficiency in term of the network latency.

2.4 Heuristic and swarm-based Routing

A new heuristic solution was proposed in [21] by Pothuri *et al.* for energy-efficient routing with latency-aware by employing topology control in WSNs using 802.11 like channel access schemes. Accordingly, the packet forwarding policies are implemented by confining a value of latency, the task of algorithm used in this protocol is to find a path from a sensor node to the sink with the lowest energy consumption, such that the total network latency incurred along the path is less than the predetermined value of latency. However, each sensor node can communicate directly to the BS with long-range radio communication cause quick energy consumption. This assumption is unsuitable for large WSNs.

Ant-based Service Aware Routing (ASAR) [22], is routing protocol interesting in the latency based on inspiration from nature. This protocol provides a model for learning paths in a hierarchical tree based on behavior of ants in foraging. ASAR make the appropriate path selection based on the requirements of different services by providing a positive feedback mechanism as the communication method of the ants (ant-based algorithm. Each cluster-head maintains two tables (optimal path table and pheromone path table - pheromone is substance produced by animals as a chemical signal to attract other members of the same species). The decision to choose the best route at a time is based on parameters such as latency, packet loss rate, bandwidth and power consumption. Main drawback of ASAR is the bottleneck problem. In addition, in large networks, new optimal path setup requires extra calculation, especially in case of network congestion.

Xiwei Zhang *et al.* proposed a new heuristic approach [1] in which a subset of nodes served as the data collection points (CPs) and sinks served as mobile elements (MEs) to receive data sent from CPs. Main purpose of this proposal is determining the optimal number of CPs for trading-off between energy efficiency and the network latency which is determined by the number of CPs and the length of trajectory of MEs. In this proposal, authors introduced a Probabilistic Path Selection algorithm to reduce the data collection latency for stochastic event detection scenario. Additionally, they developed a heuristic algorithm to select the optimal number of CPs and MEs for more general case. Problem of this proposal is that when the distribution of sensors is randomly deployed in a wide range. The MEs will not be evenly distributed, the distinction between the sensors and the MEs is difficult, even if they were the same, it will easily lead to imbalance in overall network. Thus, it makes the proposed protocol undesired efficient.

Another routing protocol based on inspiration from nature was proposed by Selcuk Okdem *et al.* [13] to solve the problem of energy efficiency by employing a swarm-based artificial intelligence algorithm based on cluster-based routing strategy using ABC algorithm. This algorithm was inspired by finding the honey of the bees. Accordingly, the bees will be served as corresponding sensor nodes involved in the process of constructing clusters to transmit data to sink. The exchange of messages between sensor nodes is the same way that bees communicate to each other in the process of path finding to source of honey. This model shows the effectiveness in utilizing the ability of data aggregation in the network, but it showed ineffectiveness on the quality of service factors (included the network latency) except for the significant savings of total energy consumption to prolonging the network lifetime.In Table 1, we compare and summarize the aforementioned routing protocols for WSNs based on characteristics as Overhead Control (O), Scalability (S), Complexity of Algorithm (C), Energy efficiency

(E) and D (Controlled Delay).

Table 1. Summarization of routing protocols

Routing Protocol	**O**	**S**	**C**	**E**	**D**
SPEED	✓		low		✓
RPAR		✓	high	✓	✓
EESR		✓	high	✓	✓
Kajikawa *et al.*	✓	✓	high	✓	✓
C2ES2	✓		high	✓	✓
ESP	✓		high	✓	✓
Clu-DAS	✓	✓	low		✓
EAQoS			high	✓	✓
MMSPEED	✓	✓	high		✓
Liming He			high	✓	✓
DEAR		✓	high		✓
Porhuri *et al.*		✓	low		✓
ASAR	✓		low	✓	✓
Xiwei Zhang *et al.*	✓	✓	low	✓	✓
Selcuk Okdem	✓	✓	low	✓	

3. RESEARCH DIRECTION: A STATE-OF- THE-ART PROPOSAL

This section presents the research direction on problems of balancing the network latency and energy consumption in WSNs. We propose a new research direction to balance the latency and energy consumption through the multi-objective optimal algorithm. As the above analysis, the method of multi-objective optimization [11], [12] has been applied to solve optimizing problems in many different domains but applying it to solve problems in WSN is not worth considering. Recently, swarm-based methods (inspired by searching for food or way of the natural creatures such as bees, ants or bats, etc.) offer many advantages compared to traditional methods. The swarm method expected to apply into the multi-objective optimization for WSNs are ant colony algorithm, bee colony algorithm, fire- flies algorithm, butterflies algorithm, monkeys algorithm, mean-variance algorithm, etc.

For instance, if we apply the multi-objective optimizing method based on bee colony algorithm, the general procedure is as follows:

- Describe the trading-off between the energy consumption and the latency as multi-objective optimizing function. Accordingly, we describe sensor nodes as bees finding honey, and the optimal solution is sources of honey that they want to reach for.
- Then we build the two-objective function using energy consumption and network latency.
- Next, we must find the initializationparameters for the objective function using random method or any.
- Finally, the bees (sensor nodes) discovery (based on the finding behavior of natural bee colony) to find the optimal value of the objective function. This step will be done repeatedly. During this process, algorithms need to remove the poor solutions and direct to the good solutions. Procedure will converge after *k* steps (the number of discovery).

4. CONCLUSION

From the analytical studies in conjunction with comparison the advantages and disadvantages of the recent researches, we give remarks and propose a new research direction to solve energy-efficient routing problem interested in latency in WSNs more effectively. We have provided a detailed analysis of the current state-of-the-art of the latency-aware energy-efficient routing techniques in WSNs mainly focused on geographic location-based routing, cluster-base routing, multi-path routing and heuristic and swarm-based routing.

Through analysis, we showed that the ability to apply new research methods for the multi-objective optimal solution inspired from nature is very feasible. Moreover, we have proposed to apply swarm algorithms for the two-objective optimization problem to trade-off the latency and energy efficiency in WSNs.

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A Review on Design, Analysis and Software Development For 100 Tonnes Capacity Overhead Crane

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Abstract

Equipment for material handling is a vital component of daily living. Without numerous material handling tools, the modern technological era is unimaginable. One piece of material handling equipment with numerous uses in a variety of engineering sectors is the crane.
The current endeavour aims to cover the entire design and analysis of an EOT crane with a 100-ton capacity.
The manual was designed in compliance with the different pertinent IS codes. Since procedural design necessitates laborious calculations, an effort is made to create software using Microsoft Visual Studio 2008 in order to minimise exhausting calculations. Using Solid Edge ST and Ansys 11, modelling and analysis of the whole crane's components and their assembly (based on the manual design) have been carried out, respectively.

Keywords: EOT crane, design, analysis, software development

Nomenclature

Rd	Loads due to the dead weight of the mechanism or component and dead weight of Those parts of the crane acting on the mechanism or the component under consideration
Rh	Loads due to weight of hook load and also it is defined as SWL of the hook
Rhi	Loads due to the weight of the hook load increased by impact factor
Rm	Dynamic loading arising from the acceleration or braking of the motion
Rf	Load arising from the frictional forces
Rw1	Loads due to the service wind acting horizontally in any direction where applicable to IS 875 (part 3)
Rw2	Loads due to the out of service wind acting horizontally in any direction where applicable to IS 875 (part-3)
Fo	Minimum breaking load
S	Maximum rope tension considering inclination of the rope in the uppermost position
Zp	Minimum partial co-efficient of utilization
Ddf	Duty factor for hoist for appropriate mechanism class
Dd	Diameter of drum measured at the bottom of the groove
d	Rope diameter
Crc	Factor depend upon the construction of wire rope
Crr	Co-efficient depending upon the type of receiving system
M	Mass of rated load on the hook plus weight of the hook block and wire rope in tones
V	Specified hoisting speed in m/min
E	Combined efficiency of gears and sheaves
Cv	Service factor depending on type of motors
Camb	Derating factor for ambient temperature
M1	Mass of rated load on the hook plus weight of the hook block and wire rope plus self weight of crane Girder in tones
V1	Specified traveling speed in m/min
F	Overall friction factor
a	Average linear acceleration of the crane or the trolley

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1. Introduction

Material handling equipment is employed for moving loads in premises or areas, de-partment, factories and plants, at construction sites, point of storage and reloading, etc.
Material handling equipment carries loads over relatively short distances, in contrast to so-called long-distance transport (railway, automobile, ocean, and air), which moves loads over a significant distance. In order to provide a consistent load transfer between two or more places connected by common production activities, these distances are often limited to tens or hundreds of meters and only occasionally reach thousands of meters.
Each business' handling and loading processes are reliant on the external and internal facilities that are available. The business receives its raw materials, semi-finished goods, fuel, auxiliary materials, etc. from outside transportation facilities.

1.1. Types of Material Handling Equipment

- Hoisting Equipment
- Conveying Equipment
- Surface and Overhead Equipment

1.1.1 Hoisting Equipment

It is a group of machines with lifting gear intended for moving loads mainly in batches. It is intended mainly for unit loads - various parts of machines and whole machines, elements of metal structure, hopper and ladles, girders, building blocks and materials, etc.

Types of Hoisting equipments are:
Hoisting Machinery
Cranes
Elevators

1.1.2 Conveying Equipment

It is a group of machines which may have no lifting gear, and which moves loads in a continuous flow. It includes all types of Conveyors.

1.1.3. Surface and Overhead Equipment

It is a group of machines which also may not be provided with lifting gear and usually handle loads in batches. conveying equipment can be used to handle either only bulk or only unit loads while surface or overhead facilities can be used to handle both bulk and unit loads. Materials handled in bulk are composed of a large number of homogeneous particles or lumps, for example: coal, ore, cement, sand, clay.

2. Types of Cranes

2.1 Electric Overhead Traveling Crane

- Single Girder Overhead Traveling Crane (up to 10 tonnes Capacity)
- Double Girder Overhead Traveling Crane (above 10 tonnes Capacity)
- Under slung Cranes (up to 10 tonnes Capacity)

2.2 Gantry Crane

2.3 Jib Crane

2.4 Tower Crane

2.5 Derrick Crane

2.6 Crawler Crane

2.7 Truck mounted Crane

2.1 Electric Overhead Traveling Crane.

Overhead traveling cranes operate using three motorized movements (lifting, trolley traverse, and bridge traverse), which provide handling within the volume of space under the crane.

2.1.1 Single Girder Overhead Traveling Crane Range

Capacity: up to 10 tonnes
Span: 0.5 to 25 meters
Lift: 0.5 to 12 meters

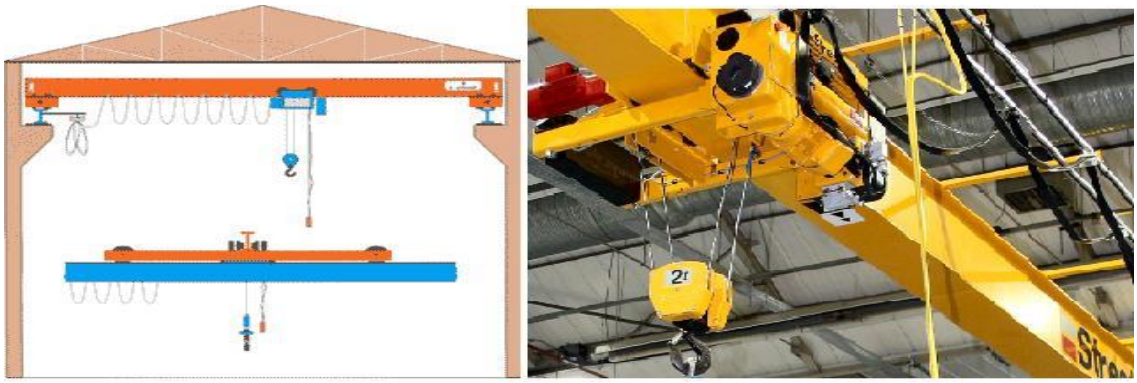

Fig.1 . Single Girder Overhead Traveling Crane

2.1.2 Double Girder Overhead traveling Crane.

When heavy load and wide span are required, double girder Overhead traveling Crane are generally used. They consist of two torsion free box girder. This makes them especially suitable for lifting and transporting load over 10 tonnes and for span of more than 25 meter.

Range

Capacity: above 10 tonnes
Span: 0.5 to 40 meters
Lift: 0.5 to 12 meters

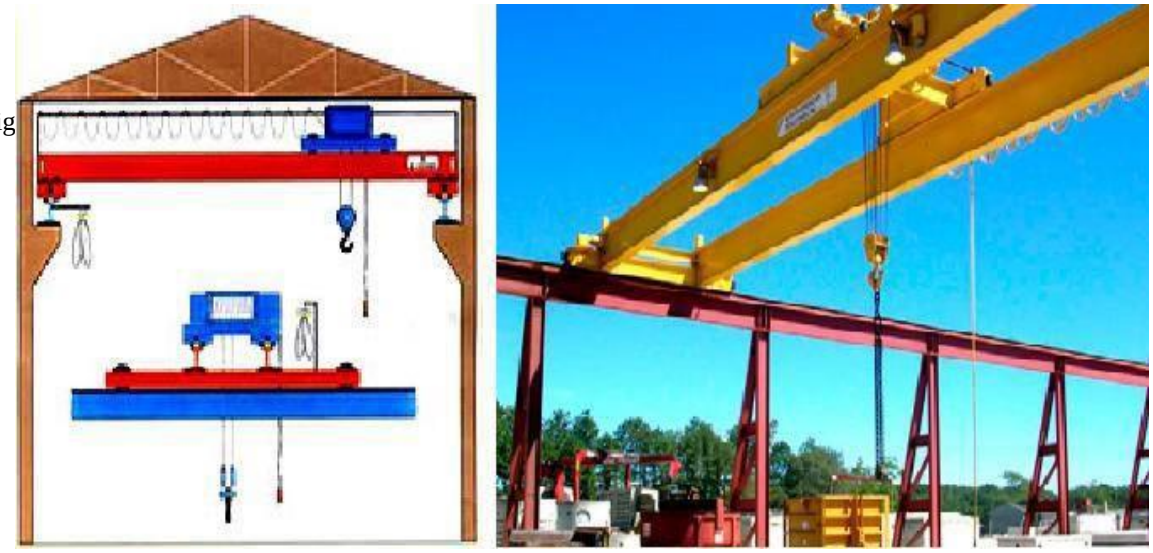

Fig.2. Double Girder Overhead Traveling Crane

2.1.3 Under slung Crane

It is a special type of crane and provides an optimal solution where the building structure makes the normal traveling cranes less suitable. The main feature is that the crane track is not fastened to pillars but to the beams of the building. Over and above these special cranes offer the advantage of very small trolley approach dimensions and as a result an optimal utilization of the building width.

Range
Capacity: up to 10 tonnes
Span: 0.5 to 25 meters
Lift: 0.5 to 12 meters

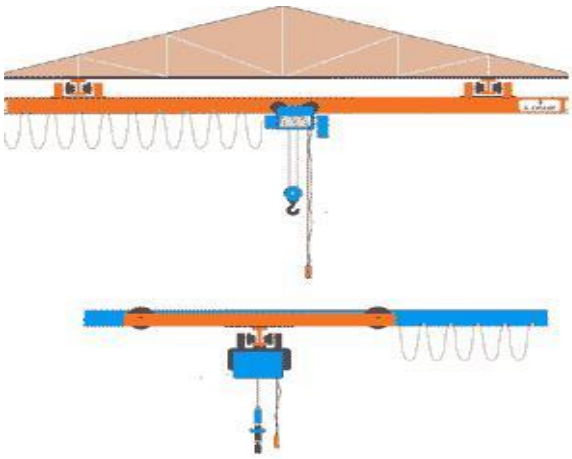

Fig.3. Under slung crane

2.2 Gantry Crane

Unlike EOT cranes, Goliath cranes run on gantry rails mounted on floor level. The bridge girders are supported on a pair of legs which are supported on end carriages. This type of crane is extremely used in shipyards and industrial installation.

Fig. 4. Gantry crane

2.3 Jib Crane

Jib crane is a type of crane where a horizontal member (jib or boom), supporting a moveable hoist, is fixed to a wall or to a floor-mounted pillar. Jib cranes are used in industrial premises and on military vehicles.

Fig. 5. Jib crane

2.4 Tower Crane

It is a crane of fixed type which by virtue of height of its supporting tower frame is capable of hoisting, luffing, and slewing its loads over high obstruction. It is most widely used in the construction of tall building.

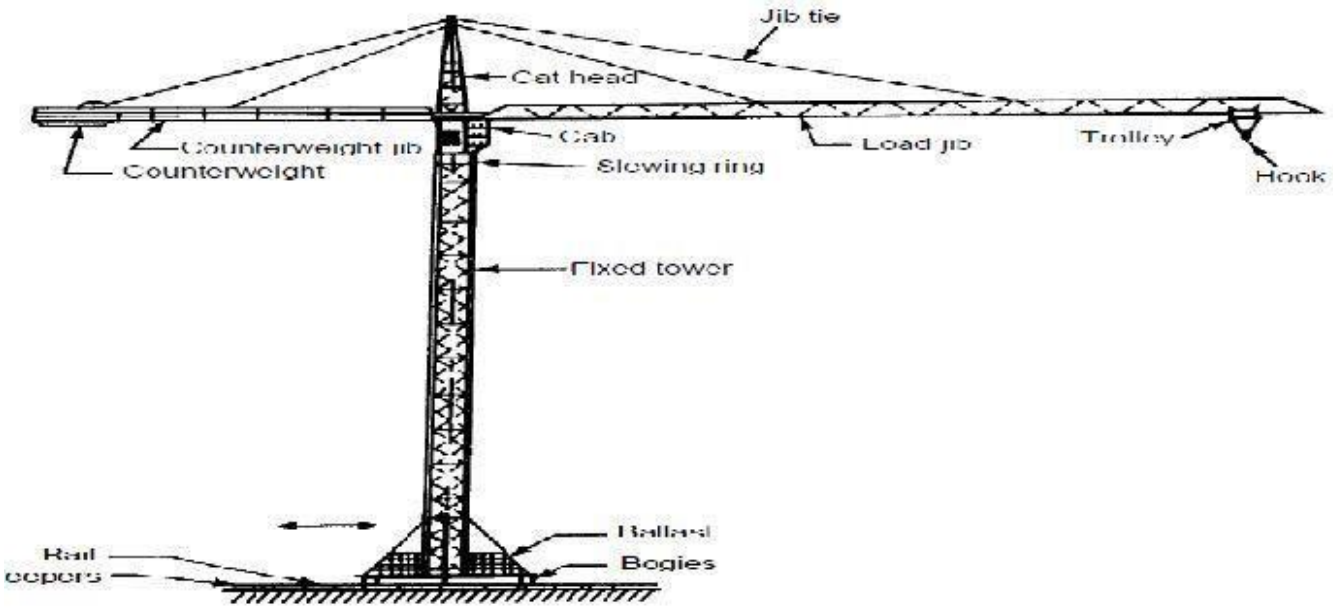

Fig. 6. Tower crane

2.5 Derrick Crane

Derrick is a strut with guys so arranged as to permit of inclination of strut in any direction, the load being raised or lowered by a hoisting mechanism.

Fig. 7. Derrick crane

2.6 Crawler Crane

A Crawler is a crane mounted on an undercarriage with a set of tracks (also called crawlers) that provide stability and mobility.

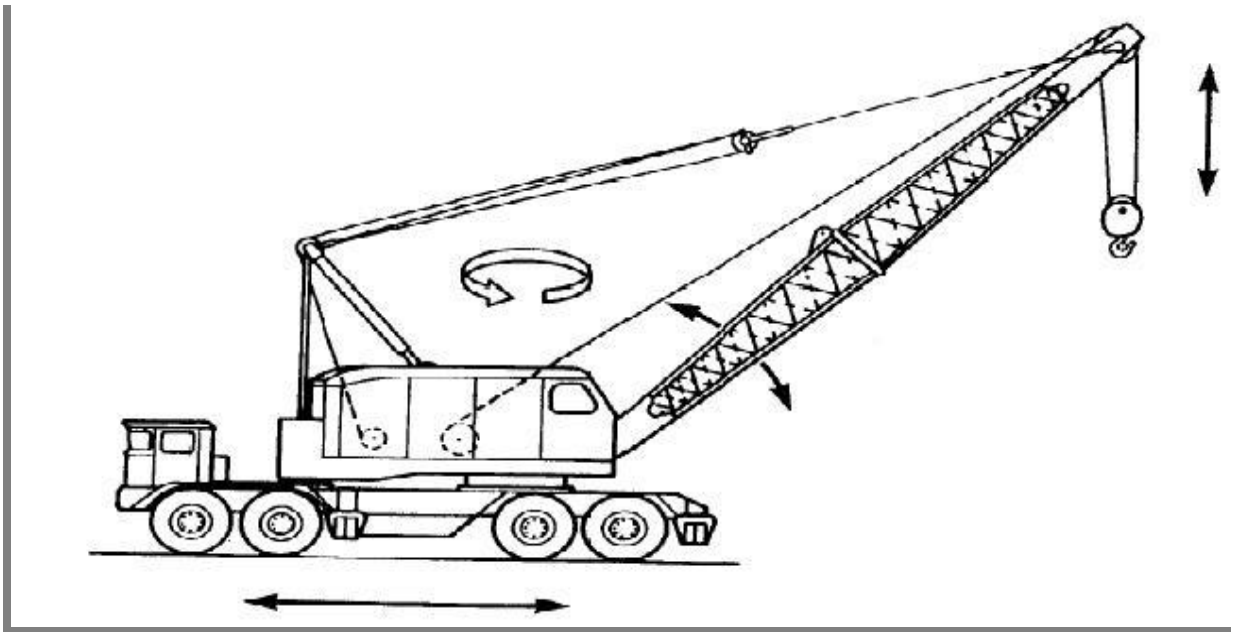

Fig. 8. Crawler crane

3. Literature Review

In the design of EOT (Electric Overhead Traveling) crane, it is necessary to have knowledge of different component used in Electric Overhead Traveling, knowledge of types of material and most important thing is to have a good knowledge of loading condition on different component. Material Handling Equipment by **N Rudenko** is the book for EOT crane design, which covers all aspects of EOT crane design. In this book **Chapter 3** covers construction of wire ropes, lays of wire ropes, which can be preferable for particular application, selection procedure of wire ropes and ho how to calculate fatigue strength (endurance) of steel wire ropes by professor Zhitkov's method. **Chapter 4** covers design procedure of pulley and drum and in this chapter, it also includes the equation which can be used in determination of crunching, shear and bending stress induced in drum. **Chapter 5** gives the idea for hook selection and sets of equation to calculate stress induced in different section of the hook, this chapter also includes crosspieces design for hook and side plate design. **Chapter 6, 8 and 9** gives guideline for selection of arresting gear, hoisting gear, traveling gear and brakes, it also includes crane wheels design. **Chapter 11** include the guideline for selecting the motor rating and determining the braking torque for hoisting motion and traveling motion**. [1]**

EOT crane are designed as per IS 3177: 1999 Code of practice for electric overhead traveling cranes and gantry cranes other than steel work cranes (second revision) **[2].** IS 2266: 2002 Steel wire rope for general engineering purpose- Specification **[3]** and IS 3973: 1984 Code of practice for the selection, installation and maintenance of wire ropes **[4]** are used for wire rope design. IS 13156: 1991 Sheave pulley blocks for wire rope - Specification **[5]** and IS 4137 Specification for sheave assembly for EOT cranes **[6]** are used in sheave design. IS 15560: 2005 Point hooks with shank up to160 tonnes - Specification (Merging of IS 3815, 6294 and 8610) **[7]** and IS 5749: 1970 Specification for Forged ram shorn hooks **[8]** are used in selection hook.
Design of structure of an EOT crane (design of crane girder and gantry girder) is the very most important and critical things. Chapter 12 of N Rudenko book gives idea on loading condition of crane girder design. Well, depending on crane lifting capacity and length of span the bridge of EOT crane are made up of plate girders, truss gird- ers, box girders, double-web girders, etc. Design of Steel Structure by S K Duggal **[9],** Design of Steel Structure by N Subramanian **[10]** are the two books to design of steel structure, chapter 6, 7 and 8 of Design of Steel Structure by S K Duggal covers design procedure of plate girder and gantry girder. The design of crane girder is satisfying the IS 807:2006 Design, Erection, and Testing (structural portion) of Crane **[11]** and also IS 800:1984 Code of practice for general construction in steel **[12].**

Dynamic study of an Overhead crane system is very interesting part of crane design. D. C. D. Oguamanam and J. S. Hansen performed a parametric study and de- rived a set of coupled, non-linear equation of motion via Hamilton principle and it was observed that location and the value of maximum beam deflection for given set of carriage and payload masses is dependent upon the carriage speed., J. S. Hansen **[13]**

At very fast speed carriage speeds, the maximum beam deflection occurs to the end of the beam where the carriage stops as a result of inertial effects and at very slow speeds occur near the middle of the beam because the system reduces to quasi-static situation. investigated the dynamics of a beam with intermediate point constraints subjected to a moving load via the method assume modes. Lee **[14]**

It was observed that point constraints resulted in a significant reduction in the deflection of the beam for slow moving loads. M. M. Stanisic is departure from the above because the position of the moving load is included in mode shapes derivation thus ensuring satisfaction of both bound- ary and transient conditions. This technique is based on use of operational calculus. M. M. Stanisic **[15]**

Muhammad Abid et al. in is paper by this study has the study arrived at a generalisation methodology that connected all the characteristics to the box girder's capacity. The created generalisation process just requires capacity knowledge as an input and outputs all of the optimised dimensions. The optimised deflection steadily rises with decreasing box girder capacity, from 40.12 mm for 100 tonnes to 47.30 mm for 50 tonnes.As the capacity decreases, the camber may be increased in accordance. On the other hand, no consideration of camber was made during the analysis. Each optimised girder showed at least a 22% mass reduction. The study came up with a generalisation methodology that linked all the traits to the capacity of the box girder. Only capacity knowledge is needed as an input for the constructed generalisation process, which then produces all of the optimal dimensions. With a reduction in box girder capacity, the optimum deflection slowly increases, rising from 40.12 mm for 100 tonnes to 47.30 mm for 50 tonnes.The camber may be raised in response to a decline in capacity. On the other hand, camber was not taken into account when doing the analysis. Each improved girder displayed a mass reduction of at least 22%.[16]

Akihito Otani et al. in investigated in this study In this study, the 1/8 scale model excitation test and the simulation analysis were used to examine the vertical scismic response of a typical 150 tonne overhead crane.The excitation test confirmed and offered a simple equation for the prediction of the overhead crane's leap. The test proved that, despite the collision occurring after the overhead crane's leap, the response force at the wheels could be predicted using linear analysis.If the leap of the overhead crane is

anticipated, it is inferred that a large margin (about 30% recommended) is required to analyse the reaction force at the wheels in the design of the overhead crane.The simulation study was performed using a nonlinear model with gap elements. [17]

Ph.D. Ya. Slavchev et al. in demonstrated in their study. A 3-D model of a double girder overhead crane's metal construction, known as model 1, has been created. Comparing the FEA model to the well-known Euler-Bernoulli model demonstrates the correctness of the FEA model. Due to the crucial influence of the connections between the main girders and end trucks as well as rotations of the supports, the carrying metal construction of model 1 is in a 3-D strained condition. The model 1's metal construction is generally well-built. It satisfies many of the requirements for contemporary double girder overhead cranes, including contemporary hoist, driving units, etc. The model 1 bridge crane's mass might still be further lowered, though.Various tests are performed on the new design models, model2 and model3, to demonstrate their adherence to theoretical considerations and demonstrate that their static reaction is comparable to that of the original crane. The majority of the types of tests involve conducting stress analysis and bridge horizontal and vertical deflection measurements. The models were found to follow theory, and their static structural reaction keeps the original crane structure's response intact. [18]

I.Gerdemeli et al. in evaluated in general, The main beam of a gantry crane's design and analysis using a numerical method are provided. In various load combination instances, analytical stress calculations and stress analysis using numerical approach are investigated. Table compares the outcomes of the analytical calculations with those of the analysis.

Table 1. Load Combination & Stress

Load Combination	SW	ST1	ST2	ST3	DY1	DY2	DY3
σ_{eqv} (MPa)	52	92	129	88	106	152	101
σ_{eqv} (MPa)	47	78	124	84	89	147	97

All of the stress results, as shown in Table 6, are less than the maximum stress that St 37-2 steel can withstand. For static loading and dynamic loading, St 37-2 steel can withstand stresses of 160 MPa and 180 MPa, respectively.
In general, it is anticipated that there will be a maximum 20% variation between analytical calculation results and analysis results. Therefore, the study's findings are acceptable.However, it is clear that the outcomes of the ST1 and DY1 cases differ from one another more than the other differences. [19]

Lasinta Ari et al. in evaluated in The simulation findings demonstrate that the gantry crane's structure has a minimum fatigue life of up to 11.770 x 10, 1.055 x 10, and 0.494 x 10 6 cycles, respectively, for loads of 7, 8, 9, and 10. While the gantry crane's framework has a safety factor of 1.296, 1.134, 1.008, and 0.907 for its 7, 8, 9, and 10 Tonne models, respectively. The minimal fatigue life of a gantry crane is fewer than 1 million cycles with a payload of 10 tonnes. [20]

Heikki Sjömanet al. in investigated ability to create products while objectively researching the case's project or process, which serves as the research's primary data source. This establishes high criteria for comprehensively documenting the project because there is a lot of information flowing in. Participatory action research has similar restrictions. [21]

International Journal of Engineering Research and General Science in is paper by public was It design necessitates putting design concepts to use in real-world business situations. The burden to be lifted was the primary factor taken into account when solving the challenge. Accordingly, hoisting speed was taken into account. The essential components in this part design are what make up any overhead automobile. This design is for a general-purpose overhead crane that is frequently used in machine shops, warehouses, and companies that remove metal. possess a lifting capacity of roughly 50 tonnes.[22]

Kamal A. F. Moustafa et al. in evaluated the motion of an overhead crane is proposed to be controlled using fuzzy logic. The research is based on an overhead crane model that incorporates cargo lifting and lowering, trolley travel and transverse cable vibration. To regulate the motion of the trolley, the motion of the cable hoisting and lowering, and the swing of the cargo, the considered model is simulated under the influence of three fuzzy logic controllers. The outcomes of the simulation provide a logically sound interpretation of the characteristics of the suggested fuzzy control approach. There are two distinct obstacles to the current issue, it should be recognised. The first step is to develop and simulate a mathematical model that describes the overhead crane. The creation of an experiment that validates the developed model presents the second hurdle. Only the first issue is addressed in the current work. However, future research will be taken into account to overcome the second issue of adapting the current work to a genuine overhead crane. Future research will also focus on the optimisation of the parameters of the membership functions of the controllers' variables as well as the consideration of transverse cable vibrations in two dimensions.[23]

Thomas Morstyn et al.in investigated This study looked into a novel solution for repurposing defunct deep mine shafts called gravity energy storage employing suspended weights. Given a mine shaft's physical specifications, it has been demonstrated how to size the suspended weight to maximise the energy storage capability. Additionally, it has been demonstrated that quicker ramp-rates raise the system's necessary short-time power rating. This means that while sizing the motor and power electronics, designers must take into account the variety of power system services to be offered. In order to examine the potential energy

storage capacity that the technology could give a former coal mining region, the United Kingdom's Midlands have been used as a case study. It has been determined that there are 340 mine shafts that could be turned into gravity storage units with energy capacities exceeding 1 MWh, offering 0.804 GWh of energy storage, using information from the United Kingdom Government Coal Authority Abandoned Mine Catalogue. This is predicated on the notion that the hung weights are made of iron ore and have a maximum weight of 3,000 tonnes. Analysis has also been done on how sensitive the predicted energy storage capacity is to these presumptions. Surveys and feasibility studies will be necessary to compare the price of the technology to other energy storage solutions and to have a better understanding of the difficulty involved in redeveloping abandoned mines. When there are chances to relieve local distribution network congestion or to store locally generated renewable energy to lower imports/exports and to boost local asset utilisation, the case for redeveloping certain mines could be further bolstered.[24]

Ibrahim A. Hameed et al. in evaluated The following are some benefits of GWO over other algorithms: ease of implementation due to its straightforward structure; reduced storage and processing needs; faster convergence due to continuous search space reduction and fewer decision variables (i.e.,,, and); ability to avoid local minima; and only two control parameters (i.e., a and C) to tune the algorithm's performance, leading to better stability and robustness.
The combination of two competing individual aim functions into a single fitness function in this study raises the possibility that enhancing one objective degrades the other and vice versa. Multi-objective GWO is suggested as a future project to simultaneously optimise each objective function separately.[25]

Mohamed Al-Hussein et al. in evaluated on job sites, a database system has been introduced to automate the crane selection process. The built data- base offers a variety of intriguing features, such as the ability to accommodate various crane kinds and measuring systems. The database's storing and querying skills are also strong. It has a useful, user-friendly interface that is backed up with graphics in a multiplatform setting. The utilisation of the suggested database system and an illustration of its key components and capacities have been shown using an actual example involving a large and critical lift. The system gets rid of hunches and the penalties of making bad decisions throughout the selection process. The technology can cut down on both the expense and the amount of time needed for the selecting process. Additionally, it offers a variety of workable options that provide the decision-maker more flexibility.[26]

4. Conclusion

Manual design of EOT cranes was carried out using IS codes, after which 3-d modelling of all components and crane assembly was carried out using Solid Edge ST. Finite element analysis of the parts and assembly was performed using An- sys 11, and the resulting stresses are well below the allowable stress limits. To minimize the time-consuming calculations of crane design (based on multiple IS codes), a software was created using Microsoft Visual Studio 2008. A full dynamic analysis was performed with the EOT crane modelled as a simply supported uniform Euler-Bernoulli beam. The pendulum's motion is believed to be flat, with minimal angular displacements and displacement rates from the vertical. It was discovered that the location and magnitude of the maximum beam deflection for a given set of carriage and payload masses are affected by carriage speed. At very rapid carriage speeds, the maximum beam deflection occurs near the end of the beam where the carriage stops due to inertial effects, whereas at very slow speeds, it occurs near the middle of the beam because the system reduces to a quasi-static state.

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