Design, Analysis and Optimization of Crane Hook Model Din 15401

N. Lenin Rakesh, Nikhil Kumar Mishra and Piyush Kumar

Abstract--- *Crane hook are highly liable component and are always subjected to failure due to accumulation of large amount of stress which can eventually lead to its failure. In this paper the design of the hook is done by analytical method and design is done for the different materials like forged steel and high tensile steel. After the analytical method design and modeling of hook is done in modeling soft-ware (pro-E) .The modeling is done using the design calculation from the modeling the analysis of hook is done in FEA software (ANSYS).*

Keywords--- *ANSYS, pro-E, Design, Analysis and Optimization.*

I. INTRODUCTION

Crane hooks are the components which are generally used to lift the heavy load in industries and constructional work. Recently, excavators having a crane-hook are widely used in construction works site. One reason is that such an co-excavator is convenient since they can perform the conventional digging tasks as well as the suspension works. Another reason is that there are work sites where the crane trucks for suspension work are not available because of the narrowness of the site. In general an excavator has superior maneuverability than a crane truck. Very few people have already worked on the optimization of crane hook. Generally material type and cross section area and radius are design parameter that affects the weight of crane hook.

Cast iron, structural steel is generally used as manufacturing material for crane hook.

The behavior of mechanical properties of different steel grades at elevated temperatures should be well known to understand the behavior of steel and composite structures at fire. Quite commonly simplified material models are used to estimate e.g. the structural fire resistance of steel structures. In more advanced methods, for example in finite element or finite strip analyses, it is important to use accurate material data to obtain reliable results.

II. FAILURE OF CRANE HOOKS

To minimize the failure of crane hook, the stress induced in it must be studied. A crane is subjected to continuous loading and unloading. This may causes fatigue failure of the crane hook but the load cycle frequency is very low. If a crack is developed in the crane hook, mainly at stress concentration areas, it can cause fracture of the hook and lead to serious accidents. In ductile fracture, the crack propagates continuously and is more easily detectable and hence preferred over brittle fracture. In brittle fracture, there is sudden propagation of the crack and the hook fails suddenly. This type of fracture is very dangerous as it is difficult to detect.

N. Lenin Rakesh, Assistant Professor, Department of Mechanical Engineering, BIST, BIHER, Bharath Institute of Higher Education & Research, Selaiyur, Chennai.

Nikhil Kumar Mishra, UG Scholar, Department of Mechanical Engineering, BIST, BIHER, Bharath Institute of Higher Education & Research, Selaiyur, Chennai.

Piyush Kumar, UG Scholar, Department of Mechanical Engineering, BIST, BIHER, Bharath Institute of Higher Education & Research, Selaiyur, Chennai.

Received: 20 Feb 2019 | Revised: 09 Mar 2019 | Accepted: 02 Apr 2019

Bending stresses combined with tensile stresses, weakening of hook due to wear, plastic deformation due to overloading, and excessive thermal stresses are some of the other reasons for failure. Hence continuous use of crane hooks may increase the magnitude of these stresses and ultimately result in failure of the hook. All the above mentioned failures may be prevented if the stress

III. METHODOLOGY ADOPTED

A virtual model of DIN 15 401 lifting hook similar to actual sample is created using pro-e software and then model was imported to ANSYS software for Finite element stress analysis and the result of stress analysis are cross checked with that of Winkler-Bach formula for curved beams.

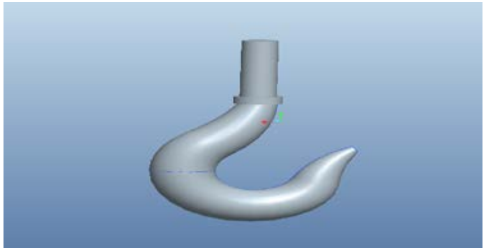
IV. PREPARATION OF CAD MODEL OF HOOK

For generation of CAD model of crane hook various geometrical features and dimensions are selected. Some features are approximated for simplification. Pro-E Wildfire 5.0 software is used for creating solid model of hook. Swept Bend advance feature in Pro-E is used. Complete Solid CAD model is prepared and it is saved in .igs format. Similarly for all required cross section solid CAD model is generated.

V. OPTIMIZATION

For optimization of crane hook, the effect of few geometrical parameters is studied by changing these parameters, like inner and outer width of the crane hook cross section. The effect on mass, displacement and stress on crane hook by varying the inner width of the hook cross section. The other dimension during this analysis remains unchanged.

VI. CIRCULAR CROSS-SECTION CRANE HOOK CREATED BY PRO-E

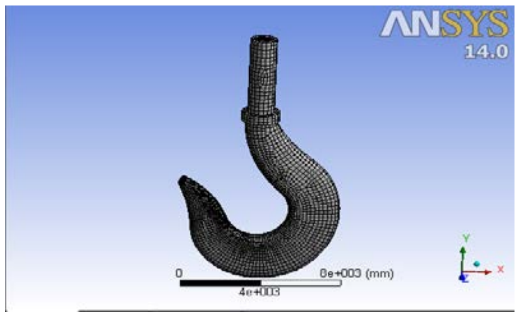


VII. TRAPEZOIDAL CROSS-SECTION CRANE HOOK CREATED BY PRO-E

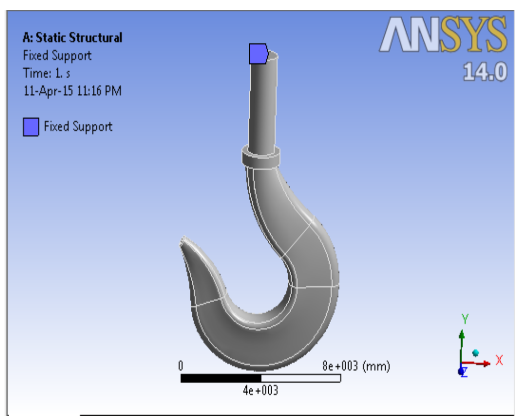
VIII. ANSYS FINITE ELEMENT METHOD

ANSYS is a finite element- based tool that provides a powerful design and analysis software package. ANSYS Mechanical software is a comprehensive FEA analysis (finite element) tool for structural analysis, including linear, nonlinear and dynamic studies. The engineering simulation product provides a complete set of elements behaviour, material models and equation solvers for a wide range of mechanical design problems. In addition, ANSYS Mechanical offers thermal analysis and coupled-physics capabilities involving acoustic, piezoelectric, thermal–structural and thermo-electric analysis. It is regarded by many researchers and engineers as a modern, accurate, robust and visually sensible tool to provide solutions for numerous engineering and scientific problems.

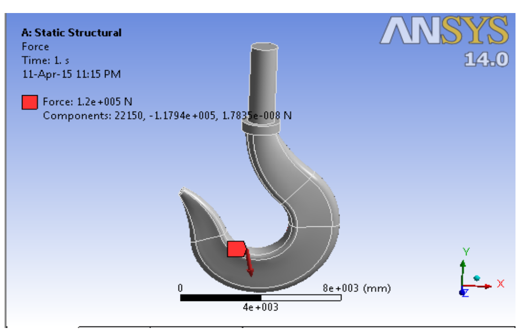
IX. MESH GENERATIN BY ANSYS



X. FIXED SUPPORT APPLIED

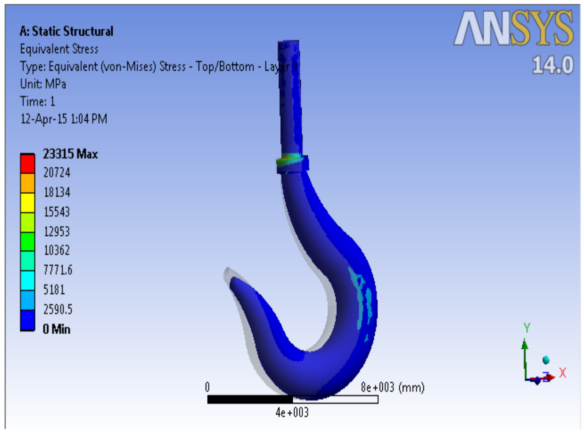


XI. FORCE 12KN APPLIED IN DOWNWARD DIRECTION

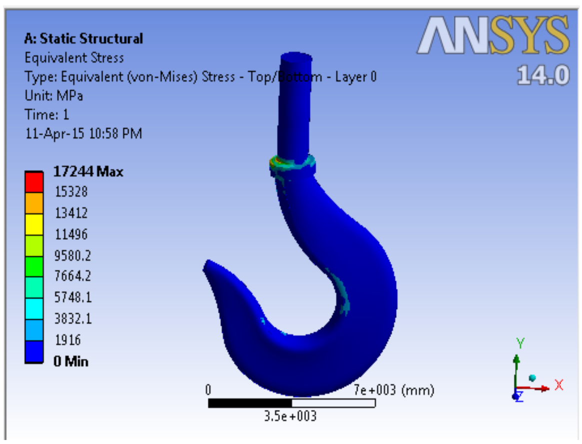


Received: 20 Feb 2019 | Revised: 09 Mar 2019 | Accepted: 02 Apr 2019

XII. Stress Comparison Between Circular Hook And Trapizodal Hook



Circular Cross-section



Trapezoidal Cross-section

XIII. Stress Comparison With 3 Different Material Of Crane Hook

Wrought Iron

Wrought iron is an iron alloy with very low carbon content with respect to cast iron. It is soft, ductile, magnetic, and has high elasticity and tensile strength. It can be heated and reheated and worked into various shapes.

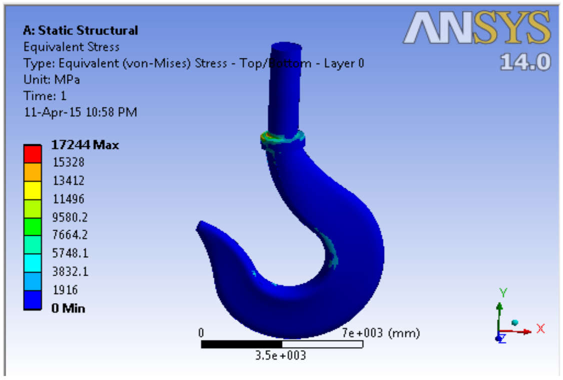
XIV. Structural Steel

Steels are alloys of iron and carbon, widely used in construction and other applications because of their high tensile strengths and low costs.

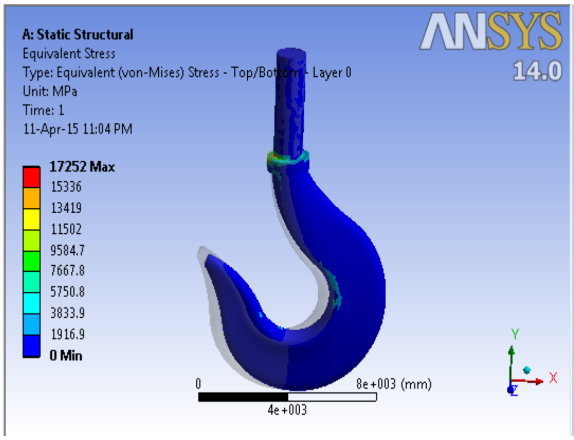
XV. Forged Steel

This is the most common process for steels. At high temperatures, the ductility is excellent. The forging temperature that can be used primarily depends on the steel’s carbon content. Steels with higher carbon content or alloying elements have lower maximum allowable forging temperatures due to their lower melting temperature. If the temperature of the steel is too high, then "burning," or incipient grain boundary melting, of the steel can occur.

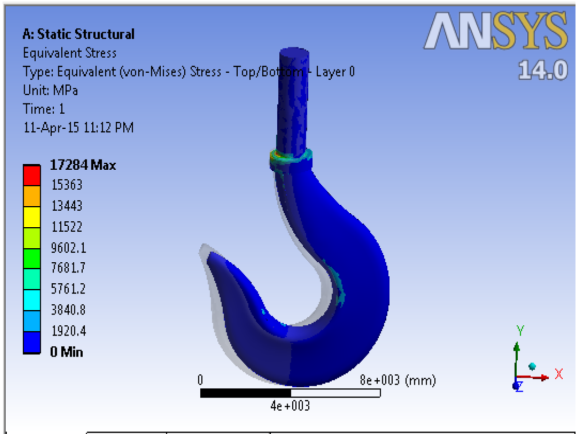
XVI. STRESS COMPARISON BETWEEN DIFFERENT MATERIALS OF HOOK



Forged steel



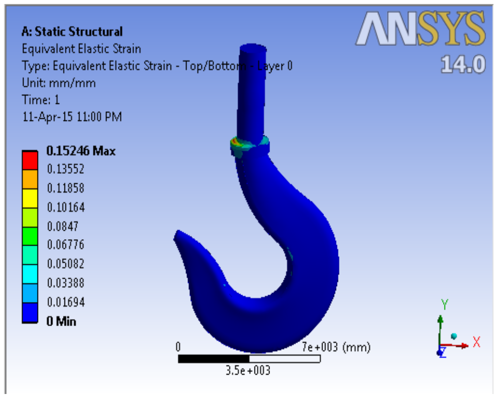
Structural steel



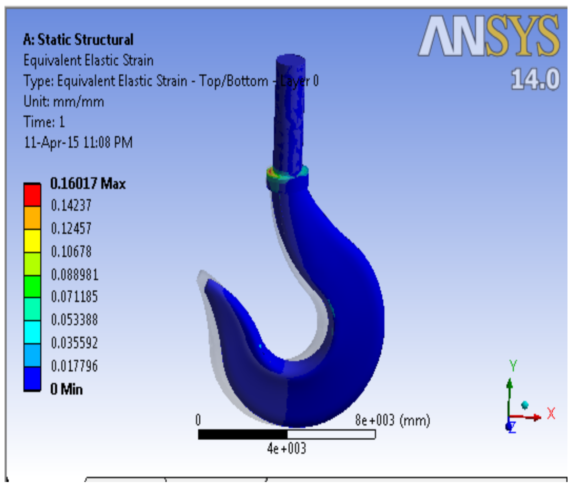
Wrought iron

International Journal of Psychosocial Rehabilitation, Vol. 23, Issue 03, 2019
ISSN: 1475-7192

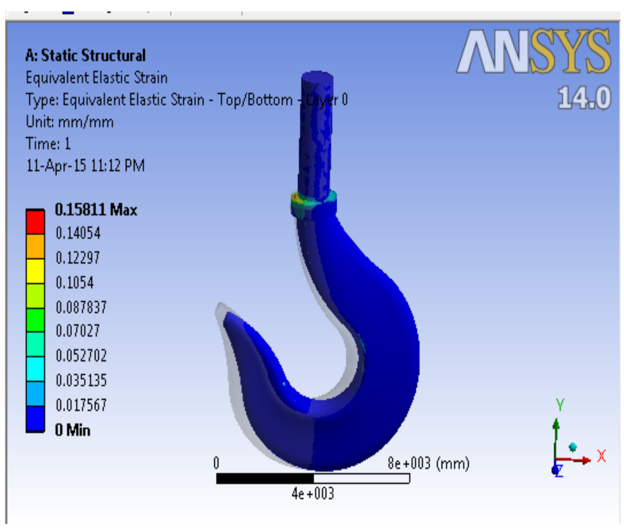
XVII. Strain Comparison Between Different Materials Of Hook



Forged steel



Structural steel

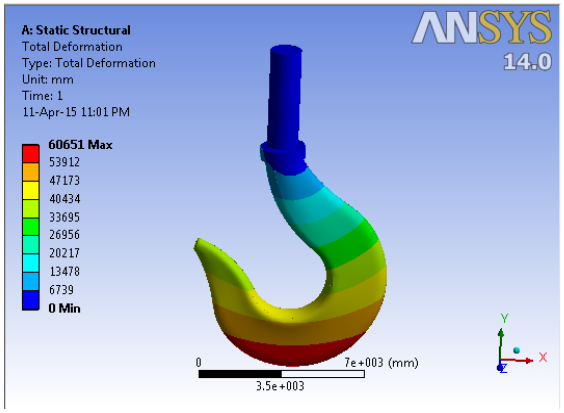


Wrought iron

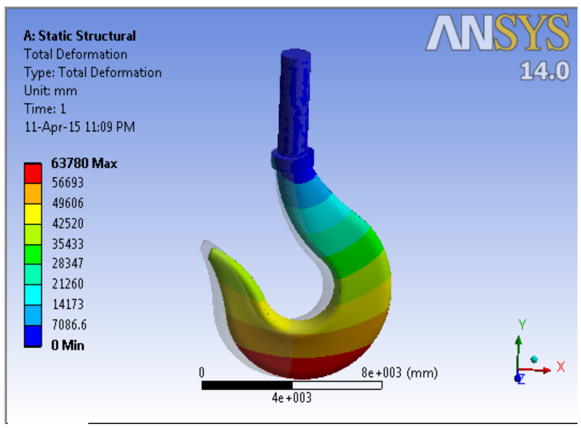
Received: 20 Feb 2019 | Revised: 09 Mar 2019 | Accepted: 02 Apr 2019

International Journal of Psychosocial Rehabilitation, Vol. 23, Issue 03, 2019
ISSN: 1475-7192

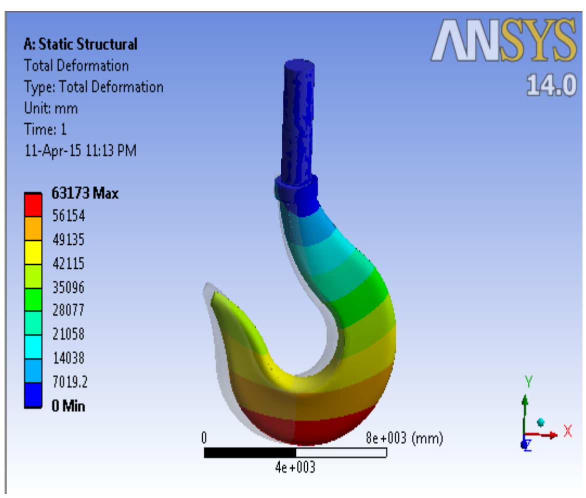
XVIII. DEFORMATION COMPARISON B/W DIFFERENT MATERIALS OF HOOK



Forged steel



Structural steel



Wrought iron

Received: 20 Feb 2019 | Revised: 09 Mar 2019 | Accepted: 02 Apr 2019

XIX. FAILURE THEORY OF VON-MISES STRESS

Von Mises stress is widely used by designers to check whether their design will withstand a given load condition.

$$\sigma_1 + \sigma_2 - (\sigma_1 \ \sigma_2) \leq \frac{\sigma_y}{FS}$$

Where, σ_1 =max stress

σ_2 =min stress

σ_y = yield stress

FS= Factor of safety

XX. BENEFITS OF THE DETERMINISTIC ANALYSIS

- Using the deterministic analysis, we have been able to investigate the performance of the design over continuous ranges of the input parameters, using a limited number of simulations.
- From the response surface, we are able to identify the key parameters really influencing the design.
- Also, we have been able to identify several candidates for the final design. Using engineering practice helps then to choose the final one.
- The deterministic approach helps identify the performance that can be reached with the actual Design (Trade Off plots)

XXI. LIMITATION OF USE

- Working load limit (WLL) should never be exceeded.
- Hook-blocks should be used in vertical lift only.
- Rigging blocks should be used only as in design specifications. Blocks should not be used for towing unless specifically designed and marked for that purpose.
- Swivels should be used in either vertical or horizontal plain only.
- Shock or side loading should not be applied unless equipment is designed for that purpose.
- Load should always be in seat of hook or eye. **Never at point!**

XXII. CONCLUSION

For the evaluation of strength and durability of machine element stress concentration factor are generally used. In order to optimize the weight of the crane hook, the stress induced in crane hook must be studied. The review of previous research permits to conclude that the curved beam such as crane hook needs more broad investigation since very few articles in this field have been published yet. The study of earlier publication enables us to conclude that it is possible to remove unwanted material where stress concentration is low and for that Finite Element Method (FEM) is one of the most effective and powerful method for the stress analysis of the crane hook.

REFERENCES

[1] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2014). Virtual instrumentation based process of agriculture by automation. *Middle-East Journal of Scientific Research*, *20*(12): 2604-2612.

[2] Udayakumar, R., Kaliyamurthie, K.P., & Khanaa, T.K. (2014). Data mining a boon: Predictive system for university topper women in academia. *World Applied Sciences Journal*, *29*(14): 86-90.

[3] Anbuselvi, S., Rebecca, L.J., Kumar, M.S., & Senthilvelan, T. (2012). GC-MS study of phytochemicals in black gram using two different organic manures. *J Chem Pharm Res*., *4*, 1246-1250.

[4] Subramanian, A.P., Jaganathan, S.K., Manikandan, A., Pandiaraj, K.N., Gomathi, N., & Supriyanto, E. (2016). Recent trends in nano-based drug delivery systems for efficient delivery of phytochemicals in chemotherapy. *RSC Advances*, *6*(54), 48294-48314.

[5] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2014). Partial encryption and partial inference control based disclosure in effective cost cloud. *Middle-East Journal of Scientific Research*, 20(12), 2456-2459.

[6] Lingeswaran, K., Prasad Karamcheti, S.S., Gopikrishnan, M., & Ramu, G. (2014). Preparation and characterization of chemical bath deposited cds thin film for solar cell. *Middle-East Journal of Scientific Research*, *20*(7), 812-814.

[7] Maruthamani, D., Vadivel, S., Kumaravel, M., Saravanakumar, B., Paul, B., Dhar, S.S., Manikandan, A., & Ramadoss, G. (2017). Fine cutting edge shaped Bi2O3rods/reduced graphene oxide (RGO) composite for supercapacitor and visible-light photocatalytic applications. *Journal of colloid and interface science*, *498*, 449-459.

[8] Gopalakrishnan, K., Sundeep Aanand, J., & Udayakumar, R. (2014). Electrical properties of doped azopolyester. *Middle-East Journal of Scientific Research*, *20*(11). 1402-1412.

[9] Subhashree, A.R., Parameaswari, P.J., Shanthi, B., Revathy, C., & Parijatham, B.O. (2012). The reference intervals for the haematological parameters in healthy adult population of chennai, southern India. *Journal of Clinical and Diagnostic Research: JCDR*, *6*(10), 1675-1680.

[10] Niranjan, U., Subramanyam, R.B.V., & Khanaa, V. (2010, September). Developing a web recommendation system based on closed sequential patterns. In *International Conference on Advances in Information and Communication Technologies*, *101*, 171-179. Springer, Berlin, Heidelberg.

[11] Slimani, Y., Baykal, A., & Manikandan, A. (2018). Effect of Cr3+ substitution on AC susceptibility of Ba hexaferrite nanoparticles. *Journal of Magnetism and Magnetic Materials*, *458*, 204-212.

[12] Premkumar, S., Ramu, G., Gunasekaran, S., & Baskar, D. (2014). Solar industrial process heating associated with thermal energy storage for feed water heating. *Middle East Journal of Scientific Research*, *20*(11), 1686-1688.

[13] Kumar, S.S., Karrunakaran, C.M., Rao, M.R.K., & Balasubramanian, M.P. (2011). Inhibitory effects of Indigofera aspalathoides on 20-methylcholanthrene-induced chemical carcinogenesis in rats. *Journal of carcinogenesis*, *10*.

[14] Beula Devamalar, P.M., Thulasi Bai, V., & Srivatsa, S.K. (2009). Design and architecture of real time web-centric tele health diabetes diagnosis expert system. *International Journal of Medical Engineering and Informatics*, *1*(3), 307-317.

[15] Ravichandran, A.T., Srinivas, J., Karthick, R., Manikandan, A., & Baykal, A. (2018). Facile combustion synthesis, structural, morphological, optical and antibacterial studies of Bi1− xAlxFeO3 (0.0≤ x≤ 0.15) nanoparticles. *Ceramics International*, *44*(11), 13247-13252.

[16] Thovhogi, N., Park, E., Manikandan, E., Maaza, M., & Gurib-Fakim, A. (2016). Physical properties of CdO nanoparticles synthesized by green chemistry via Hibiscus Sabdariffa flower extract. *Journal of Alloys and Compounds*, *655*, 314-320.

[17] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2014). Wide area wireless networks-IETF. *Middle-East Journal of Scientific Research*, *20*(12), 2042-2046.

[18] Sundar Raj, M., Saravanan, T., & Srinivasan, V. (2014). Design of silicon-carbide based cascaded multilevel inverter. *Middle-East Journal of Scientific Research*, *20*(12), 1785- 1791.

[19] Achudhan, M., Jayakumar M.P. (2014). Mathematical modeling and control of an electrically-heated catalyst. *International Journal of Applied Engineering Research, 9*(23), 23013.

[20] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2013). Application of pattern recognition for farsi license plate recognition. *Middle-East Journal of Scientific Research*, *18*(12), 1768-1774.

[21] Jebaraj, S., Iniyan S. (2006). Renewable energy programmes in India. *International Journal of Global Energy Issues*, *26*(43528), 232-257.

[22] Maadi, M., & Fouladi, K. (2015). Providing a method for extracting keywords in the Persian language. *International Academic Journal of Innovative Research, 2*(11), 34-42.

[23] Mohammad, S., & Azam, A. (2015). A model for ordering in restaurant based on QR Code without presence of a waiter at the table. *International Academic Journal of Innovative Research, 2*(12), 1-9.

[24] Thenmozhi, B.M.E., & Santhosh, J.M.E. (2015). A Survey Paper on Data Transfer via Multimedia with Steganography Methodologies. *International Journal of Communication and Computer Technologies, 3*(2), 67-71

[25] Liu, B., & Zhang, L. (2015). A Survey of Opinion Mining and Sentiment Analysis. *International Journal of Communication and Computer Technologies, 3*(2), 72-78.

[26] Huian and Adler, (2017). Organizing the Case and Contact Details for Law Firms Using Barrister Groupware with Support Vector Machine. *Bonfring International Journal of Industrial Engineering and Management Science, 7*(2), 32-34.

[27] Habibi, P., & Moridvaisi, H., (2015). Check Solar Cells and the Factors Affecting It. *International Academic Journal of Science and Engineering, 2*(6), 34-39.

[28] Pour, M.M., & Kiani, E.(2015). Image Enhancement by using the intelligent optimization algorithm with a combination of bacteria and Particle Swarm Optimization. *International Academic Journal of Science and Engineering, 2*(7), 1-9.

[29] Pakniyat, E., Talebiyan, S.R., Morad, M.J.A., & Loghmani, F. (2015). Design of Two New High-Performance Full Adders in Sub-threshold Region for Ultra-Low Power Applications. *International Academic Journal of Science and Engineering, 2*(8), 1-10.

[30] Suneetha, J., Rao, S., & Koduri, S. (2018). Identify the Shortest Path in Wireless Sensor Network using of Routing Information Protocols. *Bonfring International Journal of Networking Technologies and Applications, 5*(2), 9-11.

[31] Sureshkumar, K., Vasanthamani, S., Mariammal, M., Raj, S., & Vinodkumar, R.L. (2019). Power Quality Improvement Using Dynamic Voltage Restorer. *Bonfring International Journal of Power Systems and Integrated Circuits, 9*(1), 1-4

[32] Sharmila, S., & Jeyanthi Rebecca, L. (2013). Md Saduzzaman., Biodegradation of domestic effluent using different solvent extracts of Murraya koenigii. *J Chem and Pharm Res, 5*(2), 279-282.

[33] Asiri, S., Sertkol, M., Guner, S., Gungunes, H., Batoo, K.M., Saleh, T.A., Manikandan A., & Baykal, A. (2018). Hydrothermal synthesis of CoyZnyMn1-2yFe2O4 nanoferrites: magneto-optical investigation. *Ceramics International, 44*(5), 5751-5759.

[34] Rani, A.J., & Mythili, S.V. (2014). Study on total antioxidant status in relation to oxidative stress in type 2 diabetes mellitus. *Journal of clinical and diagnostic research: JCDR, 8*(3), 108-110.

[35] Karthik, B. (2014). Arulselvi, Noise removal using mixtures of projected gaussian scale mixtures. *Middle-East Journal of Scientific Research, 20*(12), 2335-2340.

[36] Karthik, B., Arulselvi, & Selvaraj, A. (2014). Test data compression architecture for low power VLSI testing. *Middle - East Journal of Scientific Research, 20*(12), 2331-2334.

[37] Vijayaragavan, S.P., Karthik, B., & Kiran Kumar, T.V.U. (2014). Privacy conscious screening framework for frequently moving objects. *Middle-East Journal of Scientific Research, 20*(8), 1000-1005.

[38] Kaliyamurthie, K.P., Parameswari, D., & Udayakumar, R. (2013). QOS aware privacy preserving location monitoring in wireless sensor network. *Indian Journal of Science and Technology, 6*(5), 4648-4652.

[39] Silambarasu, A., Manikandan, A., & Balakrishnan, K. (2017). Room-temperature superparamagnetism and enhanced photocatalytic activity of magnetically reusable spinel ZnFe 2 O 4 nanocatalysts. *Journal of Superconductivity and Novel Magnetism, 30*(9), 2631-2640.

[40] Jasmin, M., Vigneshwaran, T., & Beulah Hemalatha, S. (2015). Design of power aware on chip embedded memory based FSM encoding in FPGA. *International Journal of Applied Engineering Research, 10*(2), 4487-4496.

[41] Philomina, S., & Karthik, B. (2014). Wi-Fi energy meter implementation using embedded linux in ARM 9. *Middle-East Journal of Scientific Research, 20*, 2434-2438.

[42] Vijayaragavan, S.P., Karthik, B., & Kiran Kumar, T.V.U. (2014). A DFIG based wind generation system with unbalanced stator and grid condition. *Middle-East Journal of Scientific Research, 20*(8), 913-917.

[43] Rajakumari, S.B., & Nalini, C. (2014). An efficient data mining dataset preparation using aggregation in relational database. *Indian Journal of Science and Technology, 7*, 44-46.

[44] Karthik, B., Kiran Kumar, T.V.U., Vijayaragavan, P., & Bharath Kumaran, E. (2013). Design of a digital PLL using 0.35 Î¼m CMOS technology. *Middle-East Journal of Scientific Research, 18*(12), 1803-1806.

[45] Sudhakara, P., Jagadeesh, D., Wang, Y., Prasad, C.V., Devi, A.K., Balakrishnan, G., Kim B.S., & Song, J.I. (2013). Fabrication of Borassus fruit lignocellulose fiber/PP composites and comparison with jute, sisal and coir fibers. *Carbohydrate polymers*, *98*(1), 1002-1010.

[46] Kanniga, E., & Sundararajan, M. (2011). Modelling and characterization of DCO using pass transistors. In *Future Intelligent Information Systems,* 86(1), 451-457. Springer, Berlin, Heidelberg.

[47] Sachithanandam, P., Meikandaan, T.P., & Srividya, T. Steel framed multi storey residential building analysis and design. *International Journal of Applied Engineering Research*, *9*(22), 5527-5529.

[48] Kaliyamurthie, K.P., Udayakumar, R., Parameswari, D., & Mugunthan, S.N. (2013). Highly secured online voting system over network. *Indian Journal of Science and Technology*, *6*(S6), 4831-4836.

[49] Sathyaseelan, B., Manikandan, E., Lakshmanan, V., Baskaran, I., Sivakumar, K., Ladchumananandasivam, R., Kennedy, J., & Maaza, M. (2016). Structural, optical and morphological properties of post-growth calcined TiO2 nanopowder for opto-electronic device application: Ex-situ studies. *Journal of Alloys and Compounds*, *671*, 486-492.

[50] Saravanan, T., Sundar Raj M., & Gopalakrishnan K. (2014). SMES technology, SMES and facts system, applications, advantages and technical limitations. *Middle - East Journal of Scientific Research*, *20*(11), 1353-1358.