EXPERIMENTAL ANALYSIS OF AUTOMATICALLY MANUFACTURED CHAIN LINK FENCING WIRE

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ABSTRACT

Fences can be defined as arrangement that provides an obstruction, enclosure, or a boundary, made up of posts or stakes linked together by boards, wire, or rails. The chains run vertically and are bent into a zigzag pattern so that each "zig" hooks with the wire immediately on one side and each "zag" with the wire immediately on the other. The manufacturing of chain-link fencing is called weaving. A metal wire, frequently galvanized to reduce corrosion, is pulled along a rotating long and flat blade, thus making a somewhat flattened spiral. The spiral continuously rotate passing the blade and winds its way through the previous spiral that is part of the produced fence. When the spiral reaches the distant end of the fence, the spiral is cut near the blade. Then the spiral is pressed flat and the whole fence is moved up, ready for the next cycle. The end of each second spiral joins the end of each first spiral. The machine clamps both ends and gives them a few twists. This makes the links permanent. In this attempt of Experimental analysis of automatically manufacture chain link fencing wire is done. Here tensile test of Plain and Fenced wire is done for analysing effect of tensile strength on wires.

Keywords: Fencing, Galvanised wire, wire mesh, Automatic chain link.

1. INTRODUCTION

A fence is a arrangement that encircles a space, typically exterior, and is usually created from posts that are connected by panels, wire, railings or mesh. A fence varies from a wall is not having a rock-solid foundation along its entire span. A chain-link fences usually made from galvanized steel wire. The manufacturing of chain-link fencing is called weaving. A metal wire frequently galvanized to reduce corrosion, is pulled along a rotating long and flat blade, thus making a somewhat flattened spiral. The spiral continuously rotate passing the blade and winds it through the previous spiral that is part of the produced fence. When the spiral reaches the distant end of the fence, the spiral is cut near the blade. Then the spiral is pressed flat and the whole fence is moved up and ready for the next cycle. The end of each second spiral joins the end of each first spiral. The machine clamps both ends and gives them a few twists. This makes the links permanent. An enhanced version of
the weaving machine winds two wires around the blade at once, thus creating a double helix. One of the spirals is woven through the last spiral that is part of the already produced fence. This progress allows the process to advance twice as fast. Fences can be defined as structures serving as an enclosure, a barrier, or a boundary, usually made of posts or stakes joined together by boards, wire, or rails. In contrast, a “virtual fence” can also serve as an enclosure, a barrier, or a boundary, but that relies on other than physical objects on the landscape to alter an animals’ behavior. The concept of virtual fencing occurs increasingly in discussions of those whose job it is to manage Free-ranging animals; this includes stockpersons, scientists and nature conservationists. Therefore, a patent and literature search was conducted to investigate the topic of virtual fencing. The term virtual fence seems to be used in a very broad sense and different concepts of its application exist. However, they all have in common the fact that the system uses no physical barrier on the landscape. Therefore, a virtual fence can be defined as a structure serving as an enclosure, a barrier, or a boundary without a physical barrier.[2]

Knotted wire fences are used throughout the world for retention of livestock. Other types of wire fencing include single strands, diamond (chain link), welded mesh and hexagonal mesh (chicken mesh). However the subject of the present paper is only rectangular knotted mesh, with a particular emphasis on the production thereof. As an agricultural product, the primary body of knowledge on fencing has historically resided in national standards, e.g. [1, 2], with a particular focus on the geometric parameters of the fence and the coatings. The corrosion resistance of wire fences in exposed environments has been of interest for many years [3-9] and still continues to be an area of research as material science has made newer coatings available.[2]
fencing wire, as used in the fabrication of knotted wire fences. A range of physical properties was inspected: tensile strength, ductility in tension, Young’s modulus, three point bending, and bending span. [2] Sebastian Balos, Vencislav Grabulov, Leposava Sidjanin, Mladen Pantic carried out research on “wire fence as applique armour” in this they studied about the behaviour of wire fence. In this wire fences used was made from commercial high-strength patented wire and the supportingframes were made of mild steel L-profile were tested. [3] Nurudeen A. Raji, Oluleke O. Oluwolfe carried out research on “Influence of Degree of Cold-Drawing on the Mechanical Properties of Low Carbon Steel” in this they studied about the Influence of Degree of Cold-Drawing on the Mechanical Properties of Low Carbon Steel. A 0.12%w C steel wire cold drawn progressively by 20%, 25%, 40% and 50% was checked. The influence of the degree of cold drawing on the mechanical properties of the carbon steel material were studied using the tensile test, impact test and hardness test experiments in order to replicate the service condition of the nails.[4] Arshpreet Singh, Anupam Agrawal was studied about Comparison of deforming forces, residual stresses and geometrical accuracy of deformation machining with conventional bending and forming in this they studied about the Deformation machining. Deformation machining is a combination of thin structure machining and single point incremental forming/bending. [5] Junichiro Tokutomia, Kenichi Hanazaki, Nobuhiro Tsuji, Jun Yanagimoto carried out research on Change in mechanical properties of fine copper wire manufactured by continuous rotary draw bending process in this they studied about The mechanical behaviors of Cu–Sn alloy wire specimens processed by the newly proposed method of rotary draw bending are systematically investigated. It was found that during draw bending, the Vicker hardness(HV) was lower than that of the specimen subjected to wire drawing, particularly on the inside of the bend, and it was confirmed that the softening induced by plastic deformation is promoted by increasing the compressive residual energy.[6] Christina Umstatter carried out research on “The evolution of virtual fences “in this they studied about virtual fences. A virtual fence can be defined as a structure serving as an enclosure, a barrier, or a boundary without a physical barrier. [7] Siavash Rezazadeh and Jonathan W. Hurst carried out research on the Optimal Selection of Motors and Transmissions for Electromechanical and Robotic Systems With regard to the important role of motors and transmissions in the performance of electromechanical and robotic systems, this paper intends to provide a solution for the problem of selection of these components for a general load case. [8]

Fig.2 Selection of knots used in the fabrication of rectangular netted wire fencing. From left: stiff-stay, fixed, and hinge-joint knot

2.1 OBJECTIVE
- Design of fencing machine.
- Perform FEA analysis of components and check stress induced in it.
- Fabrication of automatic chain link fencing machine.
- Testing of wire fencing machine.

3. METHODOLOGY
Following figure shows the flowchart of proposed work, which is divided into 4 major steps.
Input parameter
This machine is to produce chain link fence mesh using either galvanized wire or PVC coated wire materials.
Wire Dia.: 1.5mm - 4.0mm
Mesh Size: 30mm -- 100mm
Wire Type: Low carbon steel, GI, PVC Coated wire
Mesh Width: Max 3000mm

4. DESIGN AND ANALYSIS OF MACHINE

4.1 Working Principal
Working of fencing is based on the basis of five mechanisms-
1. Wire bending mechanism
2. Wire fencing mechanism
3. Wire cutting mechanism

Fig. 3 Flowchart of Proposed Work.

Fig. 4 Wire Tensioner Assembly

Fig. 5 Wire bending assembly
Wire bending mechanism is used to bend. In this angle between tensioner and rollers should maintain and velocity of motor also control to avoid jerk and breaking.

4.2 Design of Machine Components
The quality, performance, life etc. of an engineering product, all are effected by the engineering material being used for manufacturing that product. Hence it becomes necessary to select a suitable Engineering materials for a successful engineering product. For selection of suitable materials for any engineering application / product, following factors should be considered- Mechanical strength, Stability, Ductility, Availability, Fabricability, Design, Cost

4.3 Virtual Design
CAD Modelling is done as per design by using CATIA V5 R19 and checked design flexibility. CAD is mainly used for detailed engineering of 3D models and/or 2D drawings of physical components, but it is also used throughout the engineering process from conceptual design and layout of products, through strength and dynamic analysis of assemblies to definition of manufacturing methods of components.
4.4 Analysis of Machine by using ANSYS
Virtual Model of a machine prepares using CATIA V5 software and FEA analysis is done using ANSYS Workbench R17.1.
ANSYS is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements. The software implements equations that govern the behavior of these elements and solves them all; creating a comprehensive explanation of how the system acts as a whole. These results then can be presented in tabulated or graphical forms. Systems that may fit into this category are too complex due to their geometry, scale, or governing equations.
Fig. 13 Von- misses stress of Shaft

Fig. 14 Total deformation of shaft

Fig. 13 shows maximum green region i.e. As per CAE result Von-misses stress = 11.045 MPa & Fig. 14 shows maximum deformation of shaft=0.038mm.

Fig. 15 Von-mises stress on wire bending plate

Fig. 16 Total deformation of bending Plate

Fig. 15 shows Maximum Von-mises stress on bending plate 32.025 MPa & Fig. 16 shows maximum deformation of bending plate=0.08489mm
5. EXPERIMENTATION

5.1 Trial of Machines
Before start machine check following precaution -
  a. To takes a trial we check all assembly of component is ok.
  b. All nuts and bolts are properly tights.
  c. Check oil level of reduction gear box.
  d. Wire is properly maintaining tension.

5.2 Procedure
1. Make some wire bend and lock with bending strip.
2. Switch on Machine.
3. Enter a width of fences.
4. Enter number of count.
5. Press Start switch
6. Take a reading as per table.

Trial is taken for preparation of 12 feet X 6 feet Wire Fencing with diameter of wire 2.5mm.

Table No 5.1-Trial Results on machine

<table>
<thead>
<tr>
<th>Wire Diameter</th>
<th>Fence Length</th>
<th>Fence Width</th>
<th>Time per bend wire without cutting</th>
<th>Total time</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>12 feet</td>
<td>6 feet</td>
<td>5 sec</td>
<td>20 min</td>
</tr>
</tbody>
</table>

Comparison of Trial on Manually Operated, Semiautomatic and Fully Automatic Machine.

Table No 5.2-Trial Results on Different machine

<table>
<thead>
<tr>
<th>Type of Machine</th>
<th>Manual Fencing machine</th>
<th>Semi-Automatic Fencing machine</th>
<th>Automatic Fencing machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>70 min</td>
<td>45 min</td>
<td>20 min</td>
</tr>
</tbody>
</table>

Above Table Shows that there is about 44% time saving in fully automatic machine as compared to Semi-automatic machine. Also it shows that near about 60% time saving in automatic machine as compared to manual operated Machine.
Table No 5.1 UTM results of plain wire.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>UNIT</th>
<th>DIMENSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specimen Type</td>
<td>-</td>
<td>Round</td>
</tr>
<tr>
<td>Initial Diameter</td>
<td>mm</td>
<td>2.50</td>
</tr>
<tr>
<td>Final diameter</td>
<td>mm</td>
<td>0</td>
</tr>
<tr>
<td>Cross sectional area</td>
<td>mm²</td>
<td>4.909</td>
</tr>
<tr>
<td>Original gauge length</td>
<td>mm</td>
<td>50</td>
</tr>
<tr>
<td>Final gauge length</td>
<td>mm</td>
<td>0</td>
</tr>
<tr>
<td>Pre-Load</td>
<td>%</td>
<td>0.100</td>
</tr>
<tr>
<td>Ultimate Load</td>
<td>KN</td>
<td>2.44</td>
</tr>
<tr>
<td>Ultimate Strength</td>
<td>N/mm²</td>
<td>496.945</td>
</tr>
</tbody>
</table>

Fig. 19 Universal Testing Machine

Fig. 20 Control Panel of UTM

Fig. 21 Graph of Load Vs. Displacement of Plain Wire
Table No. 5.2 UTM results of plain wire

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>UNIT</th>
<th>DIMENSION</th>
</tr>
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<tbody>
<tr>
<td>Specimen Type</td>
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</tr>
<tr>
<td>Final gauge length</td>
<td>mm</td>
<td>0</td>
</tr>
<tr>
<td>Pre-Load</td>
<td>%</td>
<td>0.100</td>
</tr>
<tr>
<td>Ultimate Load</td>
<td>KN</td>
<td>3.12</td>
</tr>
<tr>
<td>Ultimate Strength</td>
<td>N/mm²</td>
<td>635.438</td>
</tr>
</tbody>
</table>

6. RESULTS AND DISCUSSION

Comparison between experimental and FEA Results.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>FEA Output Result</th>
<th>Experimental Output Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultimate Strength For Plain Wire</td>
<td>461.67 N/mm²</td>
<td>496.94 N/mm²</td>
</tr>
<tr>
<td>UTS For Fenced Wire</td>
<td>605.29 N/mm²</td>
<td>635.438 N/mm²</td>
</tr>
<tr>
<td>Total Deformation of Plain wire</td>
<td>12.41 mm</td>
<td>21 mm</td>
</tr>
<tr>
<td>Total Deformation of Fenced Wire</td>
<td>110 mm</td>
<td>110 mm</td>
</tr>
</tbody>
</table>

Above table shows that results obtained during UTM testing were nearly equal to FEA analysis results.

7. CONCLUSION

Results obtained during UTM testing were nearly equal to FEA analysis result. Ultimate tensile test of Fenced wire is increases as compared to Plain wire. Ultimate tensile test of Fenced wire is increases due to Cold forming effect.
REFERENCES

10. Siavash Rezazadeh and Jonathan W. Hurst “On the Optimal Selection of Motors and Transmissions for Electromechanical and Robotic Systems”.

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