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It is further certified that the student has fulfilled all the requirements of Comprehensive Examination, Candidacy and SOTA for the award of Ph.D. Degree.

Professor Piyush Rai
(Supervisor)
Department of Mining Engineering
Indian Institute of Technology
(Banaras Hindu University)
Varanasi221005
India

DECLARATION BY THE CANDIDATE

I, ***ASIT SHUKLA***, certify that the work embodied in this thesis is my own bonafide work and carried out by me under the supervision of ***Professor Piyush Rai*** from ***July-2014 to December-2020,*** at the ***Department of Mining Engineering***, Indian Institute of Technology (BHU), Varanasi. The matter embodied in this thesis has not been submitted for the award of any other degree/diploma.

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Date:

Place: Varanasi (Asit Shukla)

CERTIFICATE BY THE SUPERVISOR

It is certified that the above statement made by the student is correct to the best of my knowledge.

Prof. Piyush Rai
(Supervisor)
Department of Mining Engineering
Indian Institute of Technology
(Banaras Hindu University)
Varanasi-221005
India

Prof. Piyush Rai
(Head of Department)
Department of Mining Engineering
Indian Institute of Technology
(Banaras Hindu University)
Varanasi-221005
India

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(ASIT SHUKLA)

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LIST OF ABBREVIATIONS

AISC	American Institute of Steel Construction
CEN	European Committee for Standardization
CIDECT	International Committee for the Development and Study of Tubular Structures
CHS	Circular Hollow Section
RHS	Rectangular Hollow Section
SHS	Square Hollow Section
CISC	Canadian Institute of Steel Construction
EC	Eurocode
EN	European Norm
NCL	Northern Coalfields Limited

SYMBOLS

Uppercases

A_0	cross-sectional area of the chord member
Av	shear resistant area of an element
E	Young modulus or modulus of elasticity Ov overlap ratio, expressed as a percentage
Ov, lim	overlap limit for brace shear check
N_0	applied axial force in chord
N_i	applied axial force in brace i (i = 1 or 2)
$N_{pl,0}$	axial yield capacity of the chord
N_u	axial ultimate capacity
M_0	applied moment in chord
$M_{pl,0}$	plastic moment capacity of the chord
M_u	ultimate moment capacity
$M_{ip,1,\,Rd}$	design value of the in-plane moment in brace i (i = 1 or 2)
V_{Ed}	design value of the shear force in a chord member at the gap location
$V_{pl,\,Rd}$	design value of the shear force in a chord member
$V_s *$	design resistance of the joints, expressed in terms of the axial force in member i (i = 1,2)
L_0	length of the chord in test set up
L_1	length of the brace in test set up

Lowercases

b_0	external width of the chord
b_i	external width of brace i (i = 1 or 2)
d_i	external diameter of brace i (i = 1 or 2)
h_0	external height of the chord hi external depth of brace i (i = 1 or 2)

hz	distance between the centres of gravity of the effective parts of the RHS brace
t_0	flange thickness of an I or H section chord
t_i	wall thickness of CHS or RHS brace i (i = 1 ou 2)
t_w	web thickness of an I or H chord
t_f	flange thickness of an I or H chord
θ_i	angle between the brace i and the chord (i = 1 or 2)
g	gap between the braces r inside corner radius between the web and flanges of an I or H section
σ_{yo}	yield stress of the chord
σ_{yi}	yield stress of the brace i (i = 1 or 2)
σ_u	ultimate stress ε strain ν Poisson's ratio
b_{ei}	effective width of an RHS brace
d_{ei}	effective width of a CHS brace bw effective width for the web of an I or H section
d_w	depth of the web of an I or H section
α	factor used in the equation of As be, ov effective width of an overlapping RHS brace at the connection to the overlapped brace
de, ov	effective width of an overlapping CHS brace at the connection to the overlapped brace
l_b, eff	effective perimeter for local yielding of the overlapping brace
γ_{M0}	partial safety factor for the resistance of cross sections of any class
γ_{M1}	partial safety factor for the resistance of the elements to buckling
μ	Rotation stiffness of a joint. μ = 1 for initial rotation stiffness.
A_s	shear area of a chord member

ABSTRACT

Draglines, the giant single-bucket excavators in existence today, are used mostly for the removal of overburden in large scale surface mines. Normally the, draglines are more than 4000 tons in weight, with boom length ranging from 70 m to 110 m and bucket capacity ranging from 10 m^3 to 120 m^3. The dragline boom is a key component in dragline operation. Different designs of booms are in practice to enhance the effective utilization of the dragline with minimum downtime due to major breakdown in boom. During dragline operational cycle, as bucket is directly attached to the boom point sheave, the boom is subjected to the loading and unloading loads cyclically. This cyclic loading and unloading produces high to very high stresses in the boom structure and may lead to boom failure.

The booms are constructed using hollow structural steel pipes. It consists of 3- 4 main chords and 5 -6 bracing members connected along the length of the boom. The bracing members form complex overlapping or non-overlapping joints known as boom clusters. These clusters are the complex joints, which may fail over a certain period of time.

Because the boom design incorporates number of joints, hence any design or analysis of boom structure remains incomplete without critical investigation of joints. Therefore, critical joints observed on the basis of field investigation have been chosen for the analysis of stresses within the joints. Four critical locations of the joints have been selected for in depth analysis of stresses around the interaction point of brace with the main chord. These joints have been chosen on the basis of field understanding that the repairing and maintenance activities are carried out frequently at these locations.

Two type of loading conditions, namely static and dynamic loading were observed. The static loading conditions occur during the operation, when the boom and bucket of the dragline become static for a very short period of time.

The dynamic loading conditions occur during the swing-to segment of dragline bucket cycle

with filled material for unloading the material from face to disposal site. It also occurs during the swing-back segment of dragline bucket cycle with empty bucket after dumping the material at the disposal site and returning back to the blasted face.

Accordingly, a solid 3D Model of the boom was constructed in SOLIDWORKS software as wireframe design. For performing simulations, the constructed model was imported to ANSYS software in compatible file format. Simulations were performed on ANSYS 18 using finite element analysis.

The overall structural behavior of the boom along with suspension rope, A-frame, and mast has been predicted by constructing and analyzing the structure as global beam model. The global beam model has provided the stresses in the form of direct or axial stress, bending stress and maximum combined stress on the boom structure. Deformation of the boom structure and tensile axial forces in the suspension wire ropes has also been predicted to ensure the safe functioning of the structure under the applied loading conditions. Further, the selected joints have been evaluated by analyzing the models as solid submodel. The solid sub-model has provided the Von-Mises stress; fatigue life and factor of safety in the boom cluster (joints). A separate parametric study has further been performed for the critical joint to predict stress level within this critical joint.

The design of dragline boom structure as a beam model and its analysis by using the state –of –art techniques has provided suitable insights in investigating the behavior of boom under static and dynamic loading conditions. The study has been able to propose a safe design of boom structure as the values obtained for the direct stresses, maximum bending stresses and maximum combined stresses are within the safe limits. The proposed design of the boom reveals that the main chord remains in axial compression or axial tension during the loading while bracing members are subjected to bending loads. The solid sub modeling of boom cluster (Joints) reveal that the stresses within the joints are concentrated at the fillet region. However,