CRANE ACCIDENT MINIMIZATION BY USING ANDROID APPLICATION

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ABSTRACT

The introduction of new Occupational Safety & Health Administration (OSHA) regulations has been referenced by organizations involved in crane operations as being a significant milestone in reducing the number of crane accidents. This study investigates the impact of the new regulations on the frequency of crane accidents that result in fatalities and injuries while identifying crane related hazards posing significant safety risk during crane operations. Crane related accidents were analyzed in detail to compare accident frequencies resulting in fatalities and injuries. Specifically, accidents were sorted by causes of crane accidents and types of crane failures. Every construction projects need machinery and equipment. Lifting and hoisting are important construction process tasks that require huge planning. Many kinds of projects, such as high-rise construction, the cranes are critical and one of the most commonly shared resources at the site. Therefore, efficient and safe operation of cranes is of the utmost importance in the safety, schedule, and overall success of the project. Mobile boom cranes are widely used to perform important tasks in various applications. Their mobility, unlike other types of the conventional cranes, provides an advantage of faster positioning. To study the tip-over stability, a tip-over prediction model is developed. The mobile boom crane model consists of four main body parts such as base, boom, height of building and payload. A crane is considered as stable when two or more wheel contact forces are positive, or making good ground contact enough to experience ground reaction forces. The prediction calculation from the prediction model are then Verified by simulation results. The outcomes are analyzed to make final conclusions about the tip-over stability of mobile boom cranes by developing an android application for the preconstruction planning to avoid crane tipping over. The prediction model and the results in the thesis provide a significant tool for practical application of tip-over stability of mobile boom cranes.

Keywords*: Crane tipping over, Boom length, Angle, base, stability*

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1)Introduction

Mobile boom cranes are widely used to perform important tasks in various applications. Their mobility, unlike other types of the conventional cranes, provides an advantage of faster positioning. During use, the crane base is normally fixed to the ground before lifting heavy payloads to stabilize the base and prevent tip-over.However, this compromises the mobility advantage of the mobile boom cranes. This thesis investigates a tip-over stability of mobile boom cranes

To study the tip-over stability, a tip-over prediction model is developed. The mobile boom crane model consists of four main body parts base, boom, cable, and load. In this analysis, the boom crane is assumed to be stationary, thus inducing no swing in the payload. This study provides a basic understanding of the relationship between the tip-over stability and the moment contribution from the payload mass and the boom configurationA crane is considered as stable when two or more wheel contact forces are positive, or making good ground contact enough to experience ground reaction forces. The prediction calculation from the prediction model are then verified by simulation results. The outcomes are analyzed to make final conclusions about the tip-over stability of mobile boom cranes.

1.2 COURSE OBJECTIVES:

Cranes are the most important machines on site, for transporting materials and elements vertically and horizontally. Many kinds of projects, such as high-rise construction, the cranes are critical and one of the most commonly shared resources at the site. Therefore, efficient and safe operation of cranes is very importance in the safety, schedule, and overall success of the project without any risk.

This course is intended for construction engineers, supervisors, and owners, who want to learn more about crane safety on construction sites, and how to to avoid crane overturning at site for smoot working of project . Showing simulation model and analysis of overturning moment. Also showing on at which point crane out rigger get zero reaction by using load cell weighing model attach with crane out rigger. In this study, the primary data have been collected from the questionnaire surveys which have been included some case study going to analysis .The goal of this training is to raise awareness of engineers' and management's roles, responsibilities, and influence with regard to safety on the construction worksite – including crane safety. The ASCE/CI OSHA-sponsored Crane Safety Training course will prepare engineers and supervisors to utilize their management and technical training to implement safety as a core objective of the construction project. The main objective of this project before lifting a load find out tipping angle bye calculating moment at outrig .also find out reaction on outrigger by load cell for crane stability purpose.

1.1 Type of crane

1) Crawlers' crane
2) Mobile crane
3) Telescopic crane
4) Tower crane
5) Rough terrain crane
6) Boom truck crane

1.3Type of accident

1) Crane collapses
2) Tip over's
3) Overloading
4) Falling equipment
5) Dropped loads from poor rigging
6) Working in high winds
7) Electrocutions from high voltage electrical wire contact
8) Injuries during erection or dismantling of the crane
9) Falls from crane
10) Lack of inspections
11) Mechanical failure
12) Operator error
13) Failures to Use Outriggers; Soft Ground and Structural Failure

Fig.No. 1
Crane tip-over

1.2 Impact of crane accident in construction

Due to crane accident fatality increaseand also project get slowdown .also project has to face legal issue Related.it also increase cost of project due to compensation provided to victim. As per OSHA research % of accident from 2006 to 2015 of a crane are due to following reasons.

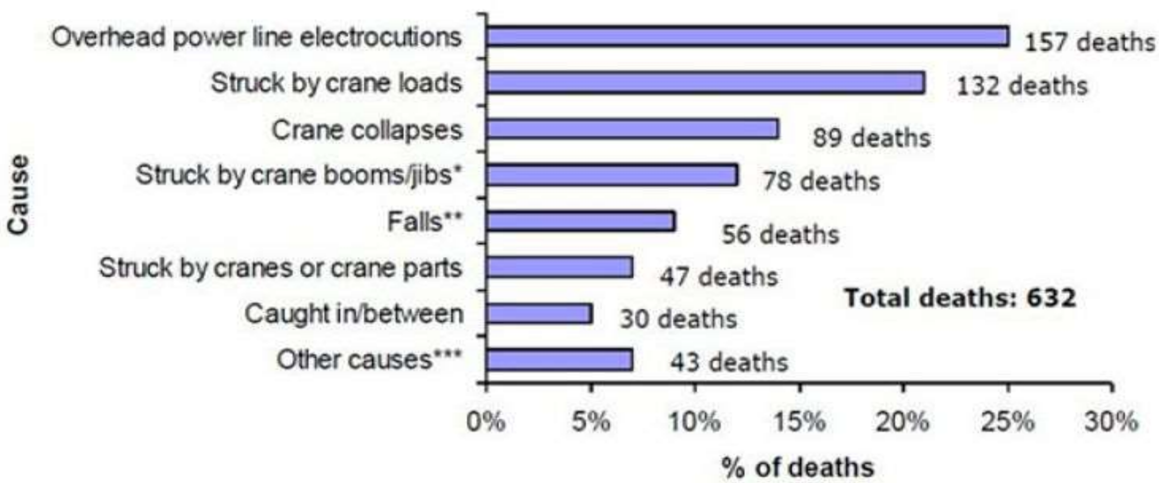

Fig no2
% of Crane Accident Reasons (2006-2015)

1.3 Reasons of overturning

A crane is considered as stable when two or more outrigger or wheel contact forces are positive, or making good ground contact enough to experience ground reaction forces. Over turning is generally happen due to when moment at one outrigger get zero due to maximum moment due to maximum length of boom, maximum load going to lift .sometimes moment increase with increasing angle of boom during operation.

The crane overturning happen due to inadequate bearing capacity of soil so that the outrigger get settled and crane consider as unstable.

2 previous studies:

Construction industry is often been subjected with the terms like “accidents”, “hazards”, “high risk” and others. Safe operation of construction equipment is essential to successful delivery of Construction projects, as most construction processes require equipment, and, furthermore, the need for equipment continues to increase. It is true that as engineers that work at a site, they have high potential on hazards and accidents. Generally, construction risk can be classified to 3 main factors, which can be categorized into three classes: due to client, due to contractor and due to designer. Cranes are involved in up to one-third of all construction and maintenance fatalities crane. Cranes, which come in numerous conjurations and are a critical component of most

construction work, contribute to as many as one-third of all construction and maintenance fatalities and injuries resulting in permanent disability Using machines have their own hazards especially tower crane machines. One of the major causes of fatalities during construction is in the use of cranes or derricks during lifting operations. Tower crane is the largest machine that been use in construction sites, yet it provide the biggest risk to site workers. Although been equipped with advance safety technologies, accidents like blind lifting and poor communication can lead to machine failure and fatality. Cases like tower crane fell from 11-storey high at construction site near Damansara on 15 April 2014 that killed MohdHafadzSanip, the operator for the crane have open engineers’ eyes on taking safety seriously. For every type of crane, they have different type of failure. For example, mobile crane fails because of poor stability during lifting and tower crane fails because of fail of crane steel support structure. These crane failures are dangerous, as it can lead to permanent disabilities or even death. Occupational Health and Safety (OSHA) had come with many standards of safety at site to minimize hazards and accidents during construction works in order to cope with the potential risks on the site. The site workers have to follow these regulations to increase safety level in their construction.

3Methodology

A) Problem base result
B) Simulation model
C) Use of load cell

3.1 Mathematical Calculation of tipping angle.

Problem-

The mobile crane is symmetrically supported by two outrigger at A and two a B in order to relieve the suspension of the truck upon which it rest and to provide greater stability. If the crane boom and track have a mass of (18tonne) and a center of mass at G1, and boom has a mass of (1.8 tons) at center of mass G2, determine the vertical reaction at each at each of the four Outriggers as a function of the boom angle θ when the boom is supportive a load having a mass 1.2 tons, plot the results measured from θ= 0 degree to the critical angle where tripping start to occur

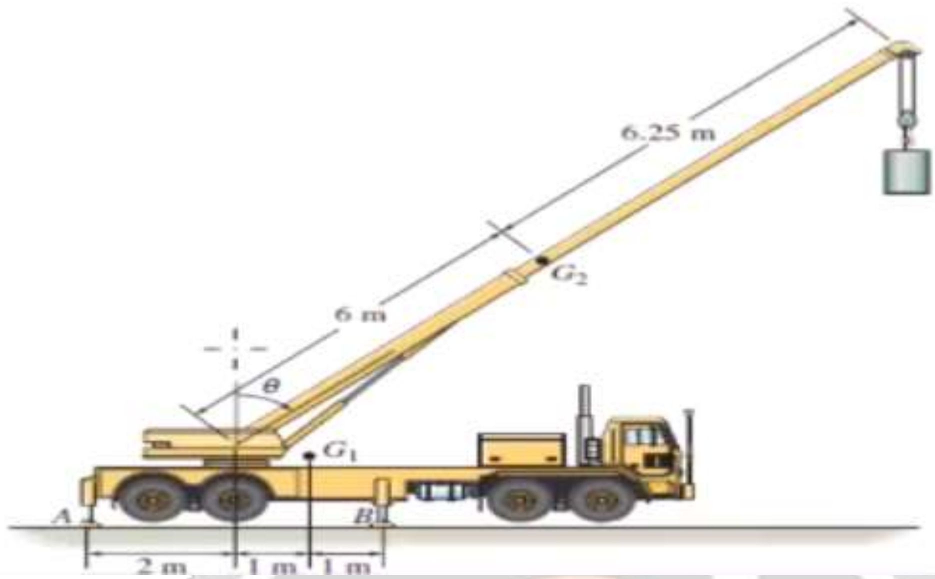

Fig. No. 3
Mobile Crane model problem

SOLUTION-
[2 in each side]
W1 = 18000 kg * 9.81 = 176.58 KN
W2 = 1800 kg * 9.81 = 17.65KN
W3= 1200 kg * 9.81 = 11.772KN
$\sum FY=0$ (↑+^{ve})
NA + NB = W1+ W2 + W3
NA + NB=206 KN……………………. … (1)
$\sum MA= 0$
NB (4) - W1 (3) - W2 (2+6Sinθ) - W3 (2+12.25Sinθ)
NB 147.15 + 62.38 Sinθ………………… (2)
Equating equation 1 And 2
NA + 147.15 + 62.38 Sinθ = 206
NA = 58.85 - 62.38 Sinθ…………………. (3)
N'A=NA/2=29.4-31.3 Sinθ
N'B = NB/2 = 73.6 = 31.1 Sinθ
@TIPPING
N'A OR NA =0 =29.4-31.3 Sinθ
θ =70.63 DEGREE

Table No 1: Reaction on outrigger at different angle.

Critical Angle Where Tripping Start To Occur.				
Sr.No	Angle θ	Angle In Radian	NA	NB
1	0	0.000	29.4	73.60
2	5	0.087	26.673	76.31
3	10	0.174	23.968	79.00
4	15	0.262	21.303	81.65
5	20	0.349	18.700	84.23
6	25	0.436	16.178	86.74
7	30	0.523	13.757	89.14
8	35	0.611	11.455	91.43

9	40	0.698	9.289	93.58
10	45	0.785	7.276	95.58
11	50	0.872	5.432	97.42
12	55	0.959	3.769	99.07
13	60	1.047	2.302	100.53
14	65	1.134	1.040	101.78
15	70	1.221	-0.006	102.82
16	75	1.308	-0.828	103.63

3.2Load cell

A load cell is a transducer that is used to create an electricalsignal whose magnitude is directly proportional to the force being measured. The various load cell types include hydraulic, pneumatic, and strain gauge. Use of load cell is proving load cell at bottom of crane outrigger to observe reaction changes .that mean at one point where reaction is zero at outrigger that indicate tipping of crane. The benefits of load cell is it show actual reaction changes at outrigger with respect to change in load or change in angle

3.3 Load Cell and HX711 Weight Sensor Module:

Load cell is transducer which transforms force or pressure into electrical output. Magnitude of this electrical output is directly proportion to the force being applied. Load cells have strain gauge, which deforms when pressure is applied on it. And then strain gauge generates electrical signal on deformation as its effective resistance changes on deformation. A load cell usually consists of four strain gauges in a Wheatstone bridge configuration. Load cell comes in various ranges like 5kg, 10kg, and 100kg and more, here we have used Load cell, which can weight up to 3kg.

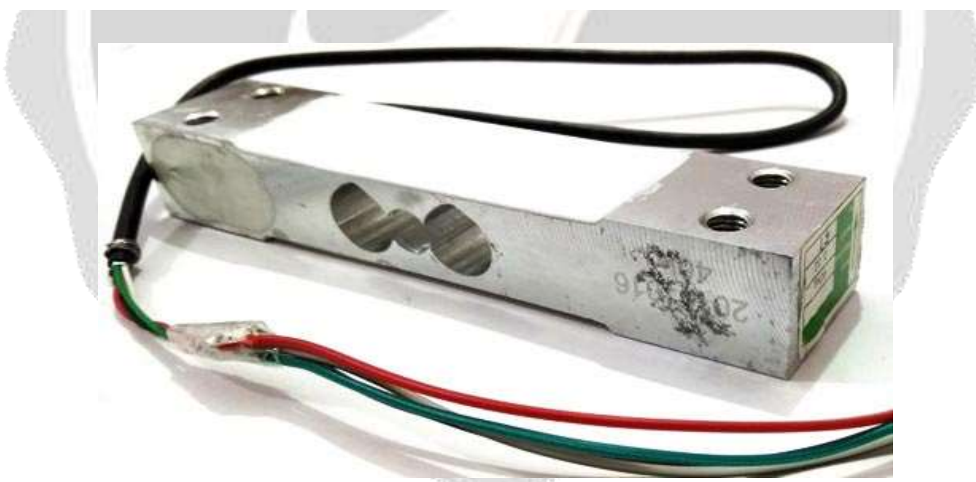

Fig no.4
Load cell

3.4 Use of load cell

Load cells are used in several types of measuring instruments such as laboratory balances, industrial scales, platform scales and universal testing machines . Current in volt convert in gram or kg by programming and transfer direct on LCD display

3.5 Required Components:
1) Arduino Uno
2) Load cell (3 kg)
3) HX711 Load cell Amplifier Module3
4) 16x2 LCD

5) Connecting wires
6) USB cable
7) Breadboard
8) Nut bolts, Frame and base

3.6Working of load cell

Working of this Arduino Weight Measurement project is easy. Before going into details, first we have to calibrate this system for measuring correct weight. When user will power it up then system will automatically start calibrating. And if user wants to calibrate it manually then press the push button. We have created a function *void* calibratefor calibration purpose, check the code below.
For calibration, wait for LCD indication for putting 100 gram over the load cell as shown in below picture. When LCD will show "put 100g" then put the 100g weight over the load cell and wait. After some seconds calibration process will be finished. After calibration user may put any weight (max 3kg) over the load cell and can get the value over LCD in grams.

Fig No 4
Digital LCD Display

In this project, we have used Arduino to control whole the process. Load cell senses the weight and supplies an electrical analog voltage to HX711 Load Amplifier Module. HX711 is a 24bit ADC, which amplifies and digitally converts the Load cell output. Then this amplified value is fed to the Arduino. Now Arduino calculate the output of HX711 and converts that into the weight values in grams and show it on LCD. A push button is used for calibrating the system.

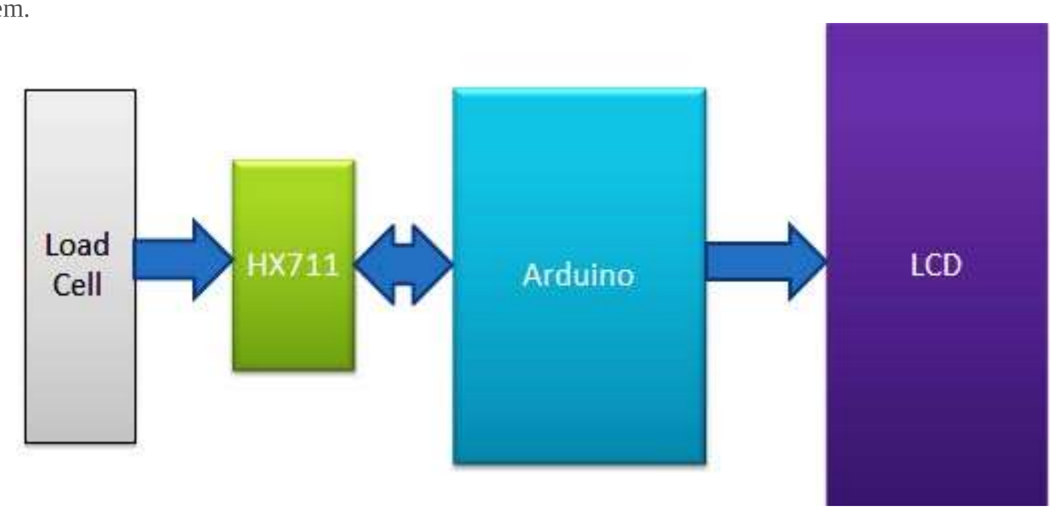

Fig no 5
Working of load cell flow chart

3.7 Android application

In this project by taking data from table no.2 android application can generate .so that when we know the mass of crane, boom length and lifting height we can cross check tipping angle or tipping load before going to lift load by crane.
Also we can connect changes outrigger reaction showing through load cell on android application. So that no need to observe crane outrigger reaction from crane working area so it also help to avoid accident due to boom swinging and observer can check result away from crane working area.

4Results:

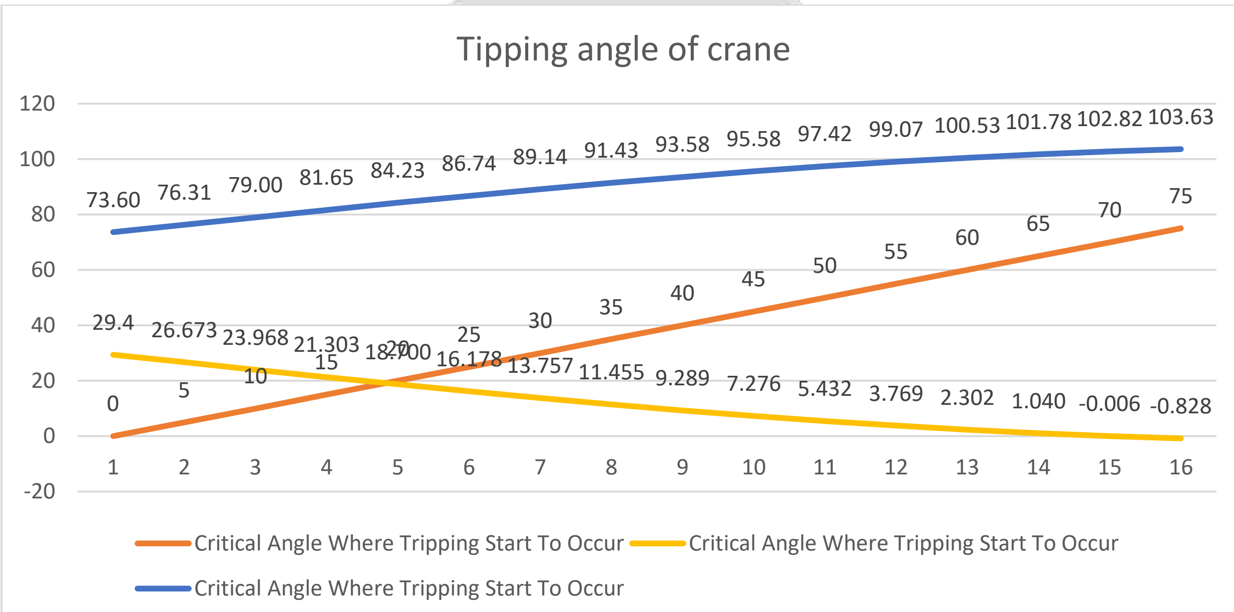

Fig No: 5
Tip-over of crane at different angle

This result shows stability of mobile boom crane at different angle with respect to load. Graph showing that when angle is increasing reaction at NA is going to reduce, so that at different angle there are reaction changes. At an angle 70 degree reaction shows in minus that indicate tipping of crane.

5 Conclusions:

Mobile boom cranes carrying loads pose a stability hazard of tipping over. During use, the crane base is normally secured to the ground before lifting heavy payloads to stabilize the base and prevent tip-over. Fixed configuration compromises the mobility advantage of the mobile boom cranes.
Preventing tip-over accidents of heavy machines, such as cranes, has a significant Benefit in terms of protecting the lives of operators and reducing the risks of damage Costs. One of the possible ways to realize this is to develop a monitoring system which can Predict when the tip-over occurs and send a warning signal.

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