Preliminary Design Review on a Transfer Trolley of Large Structures in a Hot Cell

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1. Introduction

In a hot cell the irradiated materials from reactors are handled to perform post irradiation experiments. The inside environmental conditions are very poor, with high radioactive and no direct access.

Despite this conditions, a transportation device is necessary to move radioactive structures which are large and heavy over 50 tons in weight and 30 m^3 in volume. Considering poor operating conditions a transportation device is required to be a simple structure and a passive system to minimize failure occurrences during operation.

A trolley is preliminary invented to transport large radioactive structures in hot cells. It is steel cable driving type pulled by a winch set installed outside the hot cells. It is concise and easy to maintain and has a maximum capacity 70 tons including its own weight. In this paper mechanical, electrical, and control specifications for a trolley are preliminary reviewed.

2. System description

The trolley is driven by steel cable on railway tracks. It delivers big structures like as casks, reactor core parts and canisters etc. Such body will be composed of 8 wheels, a frame without any active devices like an electrical motor or an engine system. A cable will be used to transmit torques from a motor driven roller to the trolley. The trolley is installed between the return roller and the motor drive roller. It can move forward and backward by the motor drive roller rotation. The trolley introduces a graphical User Interface (GUI) for operation in Fig. 1.

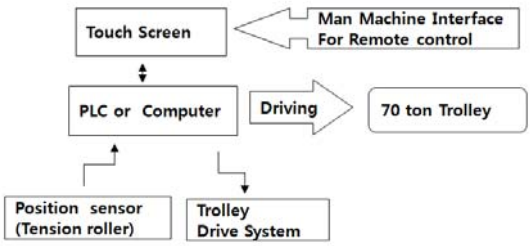

Figure 1 Control block diagram for Trolley.

There are many rollers installed to minimize friction damage caused by dragging cables on the ground. The roller setting interval will be about 300 mm. The trolley is designed to be 600 mm in a height, 6,000 mm in a length and 2,000 mm in a width as shown in Fig. 2.

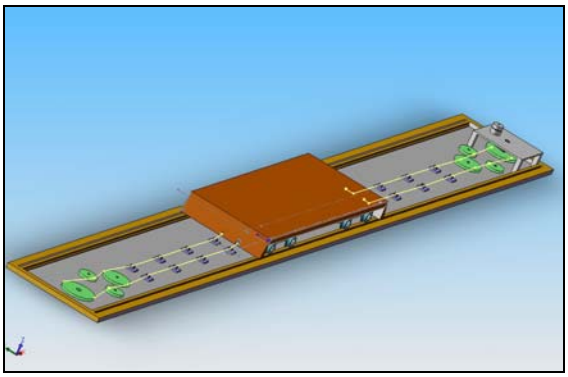

Fig. 2 Concept drawing of the cable type trolley

3. Mechanical specifications and review

3.1 Construction

To support trolley system, a hot cell building has to design to support the 90 tons weight of the trolley system. To separate trolley weight, the rails lie free-metal beams (or similar) must be placed under the wheels at right angles to the rail axis. The free metal beams can be merged on ground concrete during construction.

3.2 Rail

The rail design is to enable the trolley to be raised and withdrawn easily from the track. It require some space to maintain rail structure between rail and wall of ground surface. The top level of rail height shall be same as the ground surface level to protect from dropping effect when the trolley runs off the rails. The rail weight of 50 kg/m.

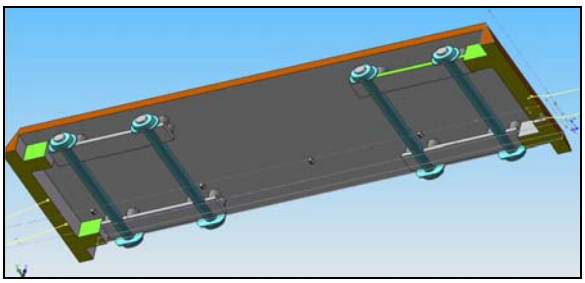

Figure 3 A trolley concept on a rail

3.3 Other components to support trolley system.

Steel-cable-driving trolley system that operated electrically shall be consists of an electrical motor, a gear system, a drive roller, a return roller, under frame & bogie, wheel axle arrangement, position sensing system, variable frequency drive system equipped control panel, etc.

Components are as followes

- Steel cable guide roller
- Steel cable tension adjust roller and position senser
- Wheel, Bumper, Bearing
- Frame and Absorption(Fig.4)
- Brake system

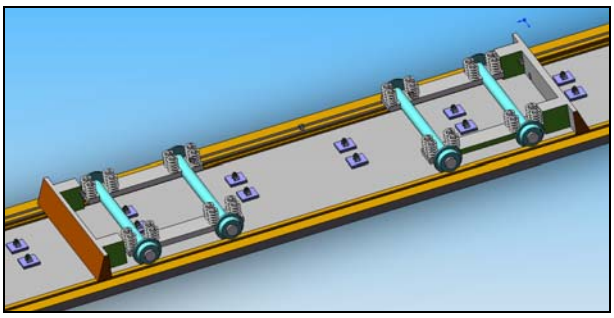

Figure 4 Frame and absorption

3.4 Driving roller and Geared system

The trolley system will implement gear control technology. It is necessary this driving roller diameter is made bigger size to minimize cable folding and valley of roller, and made sharper to pull the trolley with accuracy. It can be stopped with the emergency brake function of driving roller and brake system during any emergency situation happens like an earthquake. The brake system can be provided on the gear shaft, or a disk plate which is mounted to the roller shaft.

An AC motor is to be coupled to a suitable reduction gear to achieve the desired linear speed. Spur gears can be used to reduce the rotating speed from the geared motor. The reduction ratio of rotating speed will be reached to 1:400 to control the trolley reasonably. In that case, the control force for the trolley will be increased 400 times. This makes easy to control the 70 tons wagon with that control force. All parts of gear which are implemented to this steel cable trolley system should be sturdy, hardened & tempered with an appropriate acceptance class.

The following factors are needed to design driving function of the trolley.

- Drive roller diameter : 560 mm
- Maximum speed : 5m/min (0.083m/sec)
- Total trolley driving distance : 52 m
- Electrical motor rpm : 1200 rpm
- Required speed reduction ratio : 400:1
- Minimum required motor power : 15 [Kw]
- Designed motor : 3 state, AC 220/330V, 4 pole Wound-rotor induction motor

This system can handle heavy equipment easily and do fine control. The power of loading capacity can be increased as the rotation speed decrement of the electrical motor. This final conception specification of trolley is as followings :

- Drive operation : electrical motor with gear system
- Force transfer : roller
- Pulling capacity : max. 100.0 tons
- Steel cable : Ø20mm, 6 x 37, IWRC, 2-wire rope(or equivalent)
- Dimension : 800 mm width x 500 mm length x 600 mm height
- Weight : approximately 1 ton
- Maximum operation speed : 5m/min
- Maximum pulling distance : 60m ± 5%
- Motor capacity : 18.5KW(25hp)
- Motor type : wound-rotor induction motor
- Main beam : carbon steel, hexagon structured frame
- Main component : stainless steel
- Cover plate : stainless steel
- Operation : Digital and/or Analog Control
- Transfer trolley drive power : fine tuning type

4. Electrical requirements and specifications

All pendants except driving system shall be utilised 110V or 220V AC, single phase 50Hz or 60Hz supply. Power supply voltage of a trolley system is 415(±)10%. The complete control circuit for the system shall be housed in a common control panel suitably located on the frame base plate. All indicating instruments to be necessary to monitoring the system shall be located suitably on the control panel. An electric motors to be used for roller driving shall be complied with the appropriate Codes and Standards. Otherwise the power supply to the motor shall be 415V 3 phase at 50Hz and the motor shall be fed from a motor control centre (MCC).

5. Conclusions

The inside environmental conditions in hot cells are very poor, with high radioactive and no direct access. In consideration of As Low As Reasonably Achievable (ALARA) principle, equipments in hot cell should be simple and easy design. The trolley system proposed in this paper is easy to control the heavy loads, which are over 70 tons with an steel cable pulling system, which is consists of an steel cable, a truck , a geared motor and a few rollers only. A system reliability can be enhanced due to the simple design and reduce components.

REFFRENCES

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