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National Seminar of ISNT
Chennai, 5. – 7. 12. 2002
www.nde2002.org

MECHANISED RADIOGRAPHY FILM POSITIONING SYSTEM FOR SPROB

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Abstract

The segments of the first stage of PSLV/ GSLV Rockets are being radiographed after casting the propellant in the hardware, to check for any casting defects before further processing. The radiography is carried out in two modes, viz. radial and tangential. Each segment requires many exposures for full coverage. Current process of manual loading, unloading and positioning of the film cassette is planned to be replaced by a 'Mechanised Film Postioning System' configured and designed for reducing human fatigue. This paper presents the details of this system.

1 Introduction

The booster stage of PSLV/ GSLV comprises of five segments each of 2.8m dia and 3.2m long and contains about 29t of solid propellant cast in metallic case at the Solid Propellant Space Booster Plant (SPROB) – of Satish Dhawan Space Centre- SHAR. These segments are to be qualified by radiography for detecting defects, if any, in the grain.

The segments are subjected to radiography at the NDT facility using a 15 MeV LINAC system. The segment is located on rotary table and radiography is carried out using twin film cassettes each of size 0.3m x 0.4m. Each cassette weighs about 5 kg. During radiography after exposure of the film cassettes, the cassettes are to be replaced with fresh ones and repositioned with an over lap of the earlier exposed area by about 50mm.

After one full length of the segment is radiographed in steps , the segment which is mounted on a rotary table, is rotated to bring the next zone in line with the LINAC and the process is repeated.

Radiography of the segment is carried out in two modes viz Radial Radiography and Tangential Radiography (Fig 1). In both the cases the target is located between source and film. Further, in the case of radial radiography the film is to be located inside the port for which the cassette has to be lowered down in the port of the segment.

Nearly one hundred exposures for radial radiography and sixty exposures for tangential radiography are required for each segment.

2 Present System

At present, radiography of the segments is being carried out in a predominantly manual mode- i.e. the operations of lifting the twin cassettes to the top level of the segment, holding and lowering to the predetermined position, raising the cassettes after radiography and bringing down to the ground level – all are being done manually by using a high rise platform and a manually operated winch. Further, two separate film positioning systems are being used for radial and tangential radiography.

For the number of exposures needed for complete radiography of a segment these operations cause avoidable human fatigue. To ease the operations of film loading, unloading and positioning at the required location and thus to reduce human fatigue, **a mechanised film positioning system** is conceived and designed.

3 Salient Features of Mechanised Film Positioning System

The Film positioning system is planned to provide mechanized operations for the various motions involved in handling the film cassette so that an operator standing at ground level would be able to carryout the film positioning operations as per the predetermined procedure. Broad features/ specifications of the system conceived are:

- Common stand for both the Tangential and Radial Radiography Techniques and to suit the segment located on Rotary table.
- Overall height: 7.5 m; Radial arm length: 5.1 m
- Film cassette size 300 x 400 mm (twin)- weight 10 kg
- Motorized operations for Swing, Hoist and Radial motions.
- Swinging speed of radial arm: 45°/ min ; Range: 0° - 90°
- Hoisting speed of film Cassette: 4 m/min and 0.4 m/min; Range: 135 mm – 4210 mm with reference to top of rotary table.
- Radial motion of Carriage: 1.2 m/min Range: 0.5m-4.0m from end of arm

4 System Description

Fig 2 shows the General arrangement of the system. The system mainly consists of following components/ subsystems:

- Column
- Radial arm
- Cassettes holder
- Collapsible Guide tubes
- Carriage
- Track mounted trolley
- Hoisting drive
- Radial drive
- Slew drive

The structural system comprises of a Column and a Radial arm which hold the rest of all other systems. The height of the column is such that it clears the PS1/ GS1 segment when placed on the turn table. The radial arm swivels in horizontal plane.

The Column, the Radial arm and other items are mounted on a rail mounted Trolley. Locking arrangement of the Trolley to the rails is provided at four locations nearer to wheels to prevent movement of system during radiography process. The system is stable by virtue of configuration.

The films are mounted in the Cassette holder; which in turn is attached to two sets of collapsible tubes made out of stainless steel. The collapsible tubes are suspended from a carriage with wheels which moves on the radial arm on a track. The motion is by means of screw and nut mechanism, driven by an electric motor as shown in Fig. 2.

A 6 mm ϕ stainless steel wire rope is attached to the film cassette holder and passes over a pulley and other end is attached to the rope drum of the winch system for hoisting. The pulley is attached at the bottom of the carriage.

The winch system is attached to the bottom side of the radial arm near to the column. During hoisting of the film casette, the telescopic tubes collapse into one another as the S.S wire rope pulls up the film cassette holder; and during lowering, the telescopic tubes extend downwards due to self weight as the rope drum releases the rope by the operation of hoist motor.

The radial arm is bolted to a vertical shaft which in turn is supported on a pair of bearings- a deep groove ball bearing at top and a taper roller bearing at bottom. The bearings are housed in the column, which is a thick walled pipe. An electric motor mounted on the column drives the shaft of radial arm through a spur gear pair which gives the swing motion to the radial arm.

The radial movement of the cassette is achieved by a screw and nut mechanism (36mm –square thread) by driving the screw through a geared motor.

The control panel along with film cassette position read out system is fixed to the column at convenient height.

5 Design Features

The Cassette frame is designed to hold two films with an overlap of 10mm and assembly and dissembly is made simple by provision of latches.

The 5m long radial arm is configured as a box section to get maximum stiffness and deflection is limited to 5mm. The column is sized for bending and buckling loads. Seamless steel pipe is used and deflection is limited.

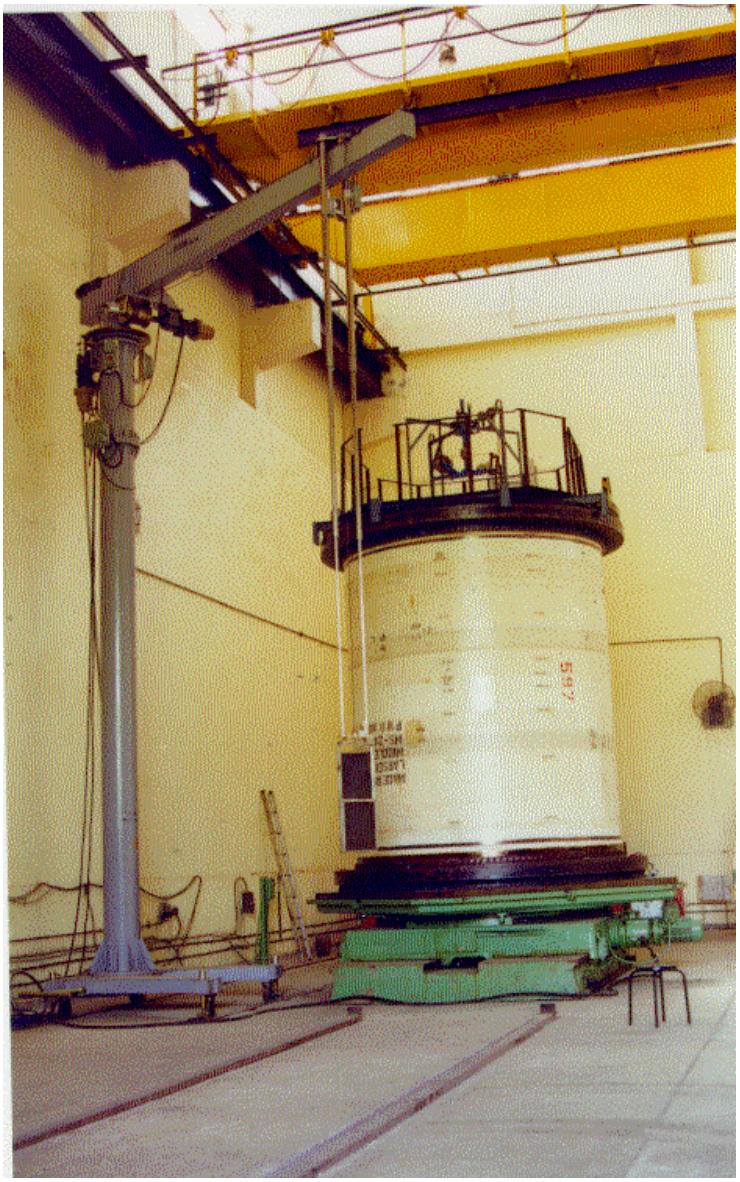
The column is supported in a trolley which moves on a rail track. Anchors are provided for rails for locking the system in position.

All the motors are geared motors.

All the drive motors and limit switches for the three drives are flame proof type. Further the hoist and swing drive motor are provided with built-in brake.

The radial movement required for the trolley is of the order of 4.5m and to take care of deflection of the screw rod due to selfweight moveable supports are provided to it.

Inter locking system is provided for the radial arm not to operate the swing drive while the film cassette is inside the segment port.



View of Radiography Film Positioning stand with PS1 Segment