

**Maintenance of hydraulic gates- Important Parameters**  
**by**  
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For regulating water discharges through the dams, canals, tunnels, penstocks or other outlets for the purposes of irrigation, domestic use, flood control, navigation, power etc, hydraulic gates form the most vital component. Among the various types of gate installations, the vertical lift and radial gates are widely adopted in India and other parts of globe. Though the gate works generally form a very small component of the total cost of the project, they are crucial structures in determining the success of the project performance and safety. Therefore reliable functional performance of gates is mandatory to assure safety of the dams, storage, control and surroundings.

Even after performing best designs, manufacture and installation of gates, there are numerous experiences of gate failures. Two major reasons are broadly attributed for such failures to regulate and control flows through gates. The first being non timely operation of the gates, due to many reasons, including lack of required skills among the field engineers and operating staff. This aspect could be overcome by proper capacity building and, adoption of scientific reservoir management techniques and safety plans The second reason is the structural failure of gates itself, due to ineffective functional maintenance, omissions and negligence in preventive maintenance, operations, quality and safety aspects, etc.

The need for reliable operation and maintenance of water control systems has received much attention in recent years due to sharing of reports, experiences and documents with in and from outside country.

To ensure reliable performance of hydraulic gates and their operating equipment, periodic preventive maintenance is essentially adhered to. For all gate installations, the respective manufacturers and BIS standards provide preventive maintenance schedules, which shall be followed. The project engineers and their professional advisers, in charge of maintenance and operation of gates have full responsibility for ensuring the reliable operation. In addition, experienced engineers and external experts in the field could be preferably associated for making a detailed and critical inspection as a second check, particularly in respect of the aging gates and allied structures and when critical operational and maintenance deficiencies are experienced. Such inspections should invariably review the maintenance program, health of the gates and hoist equipment, in addition to other allied civil structures and guide the field functionaries.

Inspection and trial testing at least twice a year i.e., pre-monsoon & post-monsoon, of the gates is very much necessary. This could, sometimes form a part of or additional to the scheduled maintenance and testing.

Therefore it is very essential to perform preventive maintenance operations of hydraulic gates for their smooth functioning, improved performance and increased life. Some of the simple but critical checks in maintenance of gate installations, if not properly and timely examined and rectified, generally lead to structural damages and sometimes disastrous situations. A few such aspects and checks and precautions are briefly projected, based on various experiences in the field, for the benefit of field staff and engineers.

Ø **Obstructions in grooves and paths of gate travel:** Check for any concrete projections, uncut steel rods or projections, non removal of ladders, scaffolding, trash or wooden pieces which cause obstruction to the gate movement in the grooves and path of gate travel. If they are not properly removed, the gates malfunction and may cause severe damages.

Ø **Approaches:** Check for any damages to the approach ladders and hand railing. Also check the joints of hand railing posts with hoist bridges and walkways to ensure safety of movement of material and men.

Ø **Accumulation of debris/mud or slush:**

If the accumulated mud/debris on the gate leaf, structural members, rollers cage, guide rollers, etc, if not flushed, cause not only operational problems but also accelerate corrosion which results in loss of strength of structural components. Debris or foreign materials accumulated between the rubber seal and its contact surface (sides and top) affect the sealing action, increases the seal friction and cause higher operational loads. Stony type gate are provided with independent roller cage with large number of free rollers and the effect of accumulated debris/mud results in increased resistance to roller movement or unequal movement. This condition may result in non rolling or jamming of rollers, sway and tilt of gate and struck in the groove. In radial gates such accumulation of mud and foreign materials at the joint between the arms and trunnions and, arms and horizontal girders result in severe corrosion and weaken the joints.

Ø **Floating logs/debris:** In reservoirs located in forest areas, the gushing inflows some times carry branched trees or other floating debris in large quantities. In partial openings of spill ways and other

out let gates, it enters into the vent opening and grooves, which cause damage to gate components. This becomes a critical issue as it may lead to non closure of gates, excess transverse movement of gate and struck in groove.

- Ø **Missing oil caps and grease cups:** In many installations, grease cups or caps .grease nipples, etc, are found missing or kept loose. Water and foreign materials enter into the narrow passages meant for forcing down the lubricant and block as the flow of lubrication. Non supply of lubricant to the bearings, increases friction and also damage the bearing and make the system non-operable. In case the lubricant is dried or polluted, the groove must be cleaned, residual materials flushed out and fresh lubricant applied. The caps are properly fixed immediately.
- Ø **Missing and Loose fasteners:** The fasteners (bolts, Screws, studs, nuts, etc,) which are missing or not properly tightened to the required torque are vulnerable areas in maintenance of joints. The bolted joints between arms and horizontal girders and horizontal girders to trunnions, lock nuts for trunnion pins, joints between tie girders to trunnion housing and, other bolted joints, in case of radial gates, if missing or loosely fixed may result failure of adjoining components or gate itself, due to insufficient strength of joint. This aspect also applies for vertical gates, in respect of joints between roller cages and gates, Guide rollers and gates, shaft locks, etc. The splice joints of bridge girders and joints between main and cross members, foundation bolts and base plates of hoist bridges, gear box to frames, Plummer boxes holding down bolts to frame, Gear shaft keys, flexible or rigid coupling bolts of shafts are some critical areas.

- Ø **Over size/Additional holes/Undersize bolts:** During erection or subsequent maintenance, if oversized holes or undersize fasteners are provided or holes made unplugged after completion of process, water/ moisture or trash enters in the gaps and damage the joints and structural members. This leads to failure of joints and also results in severe corrosion of the members which is a dangerous phenomenon in load transmitting joints and adjoining materials.
- Ø **Drain holes:** Accumulated water on girders, joints etc, due to non provision of adequate number and size of drain holes or jammed holes due to trash intrusion, particularly on the horizontal girders or at the joint areas between trunnion and radial arms and radial arms to horizontal girders and also between the cross ribs on the web of horizontal girders is an item of concern. It results in corrosion and loss of load bearing capacity. In certain gates where large quantity of water is accumulated on the horizontal girders, due to leakages or overflow and if cannot be drained off through holes, the self weight of gate increases and overload the hoist capacity which may lead to failure of gate.
- Ø **Short projection of bolts:** While providing threaded bolts at various load bearing or load transmission joints, if the projection is insufficient, the main or lock nuts cannot be properly fastened to the required depths. This will reduce bearing strength and weaken the joint which may ultimately result in joint failure. The Vertical anchor bolts connecting base plate of trunnion housing and chair, the joints of bridge girders and pier, joints between horizontal and radial arms etc, are some of such areas.
- Ø **Insufficient intrusion of anchor beams into the anchor/ trunnion box:** Radial gates with common anchorage type of installation, the anchor beams shall be inserted into the trunnion

girder/anchor boxes, so that both their flanges are in full contact throughout its width. Then the flanges are properly welded to the required size and strength. If the size and health of welds are not maintained or insufficient contact is noticed, immediate rectification action shall be taken, in no-load condition. It is experienced in a particular installation of radial gate, that the anchor beams are terminated at the upstream face of the anchor box and welded. This omission lead to failure of joint and gate was disconnected and yielded in due course. In another case the welding failed and caused in similar failure.

- Ø **Welds:** All weld joints made shall be checked for cracks, rusting and aging factors and maintained. Weld repairs shall be performed as per standards, considering the type of load and plane of its transfer. In case of differential loading, the weld designs shall be made to withstand the loads.
- Ø **Rollers and lubrication:** Effective function of all the rollers shall be established by proper lubrication and checking the condition of bearings and other components. The rolling action could be simply checked by rotating with one or two hands when the gate is above waters or when there is no water thrust. If they are not freely moving, immediately attend required maintenance or replace the damaged components. It may be noted that the rollers if jammed, offer sliding friction in gate operation which is 10-15 times higher than the rolling friction.
- Ø **Roller contact with Track face:** Ensure that all rollers are in contact with track face in the closed position of vertical gate and its travel. In such contingency, adjust the gaps with the eccentric pins provided generally in gates having more than two rollers on each side. The collars of rollers shall be checked for overriding on track.

The pitting of track shall be examined and smooth contact established through out travel of rollers.

- Ø **Guide roller/Guide Shoe:** Loose fastening of guide rollers assembly to gate body may dislocate their path of travel on the track and gate may sway or jam. If the rollers faces are rusted or no free rotation is ensured, they offer additional friction and malfunction. The rolling action shall be ensured and proper clearances with track are checked and maintained within limits.
- Ø **Gate fowling with surfaces of piers/grooves:** Fowling of gate components with surfaces of piers/grooves, and other allied civil mechanical structures due to certain omissions in designs and construction like; insufficient gap between guide rollers and track, obstructions in the path of gate travel, out of track of gate wheels or guide rollers or riding of roller flange on the track, unequal rope tensions and suspension points out of C.G points and plane, etc. In radial gates, care shall be taken that the ropes do not fowl with any part of concrete bridge or components of gate, during its entire travel.
- Ø **Rubber Seals:** Excessive seal interference (preferably 3-4 mm, or as specified) between seal and its track, uneven seal contact, back folded or damaged seals, intrusion of foreign materials between the seal and track etc, create additional frictional forces and have adverse effect on function of gate . Caulking of seal gaps with grass, gunny bags and other materials to arrest leakage at any stage, shall not be resorted to. Instead adjust the seal gap with fasteners provided to the back plate.
- Ø **Suspension System:** The following checks shall be made for the suspension system

- Check for equal tensions of ropes. It could be checked by physical inspection and preferably using strain gauges. Use turnbuckles to adjust for equal tensions, only after releasing the load (gate in closed position).
  - Check the suspension point(s) with reference to centers of gravity of gate and plane.
  - Check for any broken/damaged or rusted/corroded strands. If the damaged strands are beyond permissible limits, replace the rope releasing the load totally. Ensure proper lubrication.
  - Check for kinks , distortion of the ropes and proper riding in the grooves of drums and pulley sheaves
  - Check for proper fixing of rope clamps on drum for grip. Check for the rope winding and ensure ropes are is not out of groove and riding over the ridge of groove
  - Check for position of rope pulleys and angle of contact. Also check for any damages to pulleys , sheaves and ensure its proper movement
  - Balancing plates: In rope suspension arrangement of Radial gate installations, the position of balancing plates preferably be kept nearly horizontal, to allow its angular movement for self adjustment to maintain equal rope tensions. The suspension points connected to the balancing plates shall not be at the extreme angles, as they may not allow further adjustment or self adjustment of rope tensions.
- Ø **Counter weight and ropes:** If vertical gates are provided with counterweights, no attempt shall be made to adjust rope tensions with turn buckles, unless ropes totally released from load. The counter weight shall be properly rested on the props and ropes

adjusted for equal tensions. While doing so, the horizontality of counterweight shall always be maintained.

- Ø **Opening of covers of Plummer blocks:** It is dangerous to attempt to open the covers of Plummer blocks or adjust parallel distance of gear shafts or mating of gears, unless the gate is rested on sill and rope tensions released totally. The gear system even after release of load may be locked, as sometimes the self weight of ropes and attachments may allow down ward rotation of drum gear unit.
- Ø **Meshing of Gears:** Check for the full face width contact of teeth of gears and pinions and uniform meshing. The meshing of teeth for its full contact could easily be checked by observing area of wear. The clearances between the meshing teeth shall be within specified limits. Necessary adjustments shall be made only on release of load and locking the gear and pinion. The broken teeth, if any, have to be rectified by adopting proper methods in shop. If the damages are beyond economical repairs, replace the gears.
- Ø **Bearings:** Check for the function of antifriction bearings and rectify/replace, if not working properly. In case of excess gap between bush and shaft or oval shape of bush diameter or damaged pin, the reasons shall be probed and immediate action to rectify the deficiency. This phenomenon is complex if the wear in trunnion bush or pin is not uniform and necessary rectification/replacement shall be taken up under expert guidance. For all types of anti friction bearings, effective supply of lubrication shall be ensured.
- Ø **Drive Unit components:** The following important checks shall be made

- Electro-magnetic/Thruster brake: Check for, clearance between brake shoe and drum, wear of brake shoes and function of solenoid/magnetic coil. Ensure that the Brake drum and liners are free from grease / oil. Check the solenoid/magnetic coil for its rating.
  - Worm Reducer: Check for oil level and smooth operation. Examine the oil in the sump for any metal particles, which establishes that there is wear of teeth of worm wheel and remedial action taken immediately.
  - Check function of safety switch and ensure the cranking handles are removed, before operating the gate on power.
  - Ensure condition of chain links and its meshing with sprockets provided for manual operation.
- Ø **Line shafts:** Check the line shaft for its alignment and float. The line shaft couplings connecting drive unit and gear boxes shall be checked for its proper fastening and parallelism of faces. Also ensure proper supports to line shafts and its bearings to avoid possible float. Any deformation of shafting and rusting of components shall be inspected and maintenance taken up.
- Ø **Gate position indicators:** The function of gate lift indicators/ dial gages is to be checked and adjusted as per requirements. Their failure, if unnoticed and the gate is lifted beyond the full opening, it may hit the hoist bridge in case of vertical gates or overturn in case of radial gates. In SG hoists, the screw rods may bend on further lowering beyond the gate seat on sill. In addition to gate lift indicators, water level markings may be made on the piers and at important places to monitor gate travel in case of contingency and as a cross check

- Ø **Repairs to Painted areas:** The painted surfaces are damaged due to many reasons including, improper surface preparation, type and quality of paints and application methodology, water quality etc. The damaged painted surfaces results in corrosion of the material which is a dangerous phenomenon to the structure. If the damage occurs to the primary coat, the corrosion effect is worse and such areas shall be clearly marked and the surfaces cleaned and painted as per standards.
- Ø **Electrical cables and connections:** Check the cables, connections, junction boxes, kit-Kats etc, in each circuit to ensure continuity and proper earthing. Avoid loose contacts in the main switch, starters, motors and brakes etc. During the test operation or regular operation of gates, measure the torque taken by of motor and compare with the rated range. If excess, stop operation, probe the reason and rectify. It is safe not to operate the gate till the deficiency is rectified.
- Ø **Back-up Power:** Working condition of back-up power source shall be established.

It is reiterated that however the above checks broadly fall part of the periodical preventive maintenance schedules applicable to each installation based on the recommendations of manufacturer and BIS codes, the above checks are primarily important and made before operation of gates.