"TRUNNION BASCULE BRIDGE STATIC STABILIZING SYSTEMS"

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THERE ARE MANY CONTRIBUTORS TO FAULTY OPERATION OF MOVABLE BRIDGE MACHINERY - SOME OF THEM QUITE OBVIOUS - DIRT, DEBRIS, LACK OF PROPER LUBRICATION, INCORRECT INSTALLATION - TO NAME A FEW. FREQUENTLY, HOWEVER, CONDITIONS THAT ARE NOT SO APPARENT CAUSE THE UNWANTED RESULTS.

TRULY THE DESIGNERS OF MOVABLE BRIDGES ARE FACED WITH AN ENIGMA. ON ONE HAND THEIR MISSION IS TO DESIGN A STRUCTURE THAT IS MOVABLE - FLEXIBLE IN IT'S MODES. A BRIDGE THAT IS QUICKLY AND RELIABLY MOVED FROM ONE POSITION TO ANOTHER - MOVING EXPEDIENTLY FROM A CLOSED CONDITION TO PERMIT THE PASSAGE OF VEHICULAR TRAFFIC TO AN OPEN POSITION SO THAT MARINE TRAFFIC MAY PASS. ON THE OTHER HAND, WITH THE BRIDGE IN THE CLOSED POSITION THE GOAL IS TO HAVE THE SPAN JUST AS RIGID AS A FIXED SPAN IN ORDER TO FIRMLY SUPPORT THE APPLIED LIVE LOADS.

IN THE CASE OF VERTICAL LIFT, SWING SPAN AND SINGLE LEAF ROLLING LIFT BASCULE BRIDGES THIS IS A RELATIVELY STRAIGHT-FORWARD TASK. HOWEVER, SINGLE AND DOUBLE LEAF TRUNNION BASCULES ARE MORE DIFFICULT TO STABILIZE IN THE CLOSED POSITION. AS A RESULT THE PASSAGE OF VEHICULAR TRAFFIC CAN CAUSE THE SPAN TO MOVE THUS INTRODUCING LOADS - YES, SEVERE SHOCK LOADS - TO THE MACHINERY COMPONENTS AND INTERFACES OF THE FIXED AND MOVABLE STRUCTURES.

OFTEN CRACKING OF CONCRETE PIERS, FRACTURE OF GEAR TEETH AND FAILURE OF TRUNNION BEARINGS IS THE ULTIMATE CONSEQUENCE OF AN INADEQUATE OR IMPROPERLY ADJUSTED STABILIZING SYSTEM.

INTERESTING ISN'T IT ? TO HAVE DYNAMIC ELEMENTS FAIL IN AN APPARENT STATIC MODE. THE FACT IS, GREAT DAMAGE CAN BE DONE TO THE MACHINERY WHILE IT IS NOT OPERATING, OFTEN MORE SEVERE AND DESTRUCTIVE THAN THE EFECTS OF NORMAL OPERATION.

FOR OUR DISCUSSIONS WE SHALL REFER TO THE COLLECTIVE ELEMENTS THAT SECURE THE SPAN IN THE CLOSED POSITION AS THE "STABILIZING SYSTEM". SUCH A SYSTEM CAN INCLUDE SOME OR ALL OF THE FOLLOWING COMPONENTS :

1. MACHINERY AND/OR MOTOR BRAKES
2. SPAN LOCKS
3. LIVE LOAD SHOES
4. TAIL OR COUNTERWEIGHT LOCKS
5. COUNTERWEIGHT STABILIZERS OR ANCHORAGES

LET US LOOK BRIEFLY AT EACH OF THESE DEVICES :

BRAKES

AS REQUIRED BY AASHTO, MECHANICALLY OPERATED BRIDGES SHALL HAVE TWO SETS OF BRAKES; THE MOTOR BRAKES LOCATED ON THE MOTOR OR PRIME MOVER SHAFT; AND THE MACHINERY BRAKES LOCATED AS NEAR THE RACKS AS PRACTICAL. NOTICE THE LANGUAGE, THE WORD "POSSIBLE" IS NOT USED - THUS LEAVING IT UP TO THE DISCRETION OF THE DESIGNER AS TO WHAT THE CLOSEST PRACTICAL LOCATION IS. AASHTO ALSO MAKES PROVISION FOR ONLY ONE SET OF BRAKES ON MECHANICALLY OPERATED BRIDGES.

BRAKES HAVE TWO PURPOSES :

1. TO STOP THE SPAN WITHIN A SPECIFIED PERIOD OF TIME.
2. TO HOLD THE SPAN STATIONARY AGAINST A SPECIFIED WIND PRESSURE.

HERE IT MAY BE UNDERSTOOD THAT SETTING THE BRAKES WHEN THE SPAN IS IN THE CLOSED POSITION ALSO PREVENTS THE LEAF FROM "ACCIDENTALLY" POPPING OPEN.

SOME OLDER BRIDGES ARE EQUIPPED WITH FOOT OR MANUALLLY OPERATED BRAKES; HOWEVER, MOST MOVABLE BRIDGES HAVE EITHER THRUSTOR OR SOLENOID TYPE BRAKES. THESE ELECTRICALLY OPERATED UNITS ARE "FAIL/SAFE" DEVICES THAT ARE RELEASED BY THE ACTION OF THE THRUSTOR OR SOLENOID SO THAT MOVEMENT OF THE SPAN CAN OCCUR. THE BRAKES SET AUTOMATICALLY WHEN THE THRUSTOR MOTOR OR SOLENOIND IS DE-ENERGIZED, WHETHER BY ACCIDENTAL OR INTENTIONAL POWER INTERRUPTION.

TYPICALLY THE BRAKES ARE LOCATED AT THE HIGH SPEED OR INPUT END OF THE GEAR REDUCTIONS. THIS FOR TWO REASONS :

1. AASHTO SPECIFIRES THIS LOCATION FOR THE MOTOR BRAKES.
2. IT IS THE MOST ECONOMICAL LOCATION.

IT IS APPARENT THAT A MUCH SMALLER, LESS COSTLY BRAKE CAN BE USED AT THIS LOCATION SINCE ITS BRAKING FORCE IN TERMS OF TORQUE AT THE TRUNNION IS INCREASED IN PROPORTION TO THE OVERALL GEAR REDUCTION OF THE MACHINERY TRAIN. IN OTHER WORDS THE MECHANICAL ADVANTAGE OF THE GEAR SYSTEM IS UTILIZED TO ACHIEVE ADEQUATE BRAKING TORQUE.

THERE ARE ALSO DISADVANTAGES OF THIS LOCATION :

1. SHOULD A SHAFT BREAK, COUPLING SEPARATE OR OTHER CONDITION OCCUR SO THAT NO RESISTANCE IS PRESENT

ON THE SHAFTS OR GEARS FROM THE BRAKE TO THE RACK PINION, BRAKE CONTROL OF THE SPAN IS LOST.

2. THE COLLECTIVE CLEARANCES OF THE GEAR MESHES (BACKLASH) MUST BE TAKEN UP BEFORE BRAKING OCCURS WHICH CAN RESULT IN SHOCK LOADING.

SPAN LOCKS

THE TIPS OF BASCULE LEAFS ARE FITTED WITH LOCKS IN ORDER TO PROVIDE A CONNECTION TO ITS MATING LEAF IN THE CASE OF TWO LEAF BRIDGES, OR TO THE REST PIER IN THE CASE OF A SINGLE LEAF BRIDGE.

ON A DOUBLE LEAF BRIDGE THE LEAFS MUST BE JOINED WITH SUCH A SHEAR CONNECTOR SO THE LEAFS WILL DEFLECT TOGETHER WHEN UNSYMMETRICAL LIVE LOADS EXIST. ON A SINGLE LEAF BRIDGE, OF COURSE, THE MAIN PURPOSE IS TO PREVENT ACCIDENTAL OPENING AND MAKE CERTAIN FIRM CONTACT IS MAINTAINED WITH THE LIVE LOAD SHOES.

WHETHER THE BRIDGE IS SINGLE OR DOUBLE LEAF THE CENTER LOCKS ARE INTENDED TO CARRY ONLY VERTICAL LOADS. THEIR PURPOSE IS NOT TO ALIGN THE SPAN HORIZONTALLY; IF SUCH ALIGNMENT IS REQUIRED IT SHOULD BE ACCOMODATED WITH A CENTERING DEVICE.

A VARIETY OF DIFFERENT TYPES AND DESIGNS OF LOCKS ARE CURENTLY IN USE; INCLUDING : BAR TYPE, JAW LOCKS, SNAP LOCKS AND OTHERS - HOWEVER, THEIR PURPOSE REMAINS THE SAME : TO PROVIDE A VERTICAL CONNECTOR BETWEEN THE LEAFS OR WITH THE REST PIER.

LIVE LOAD SHOES

TRANSFER OF LIVE LOADS FROM THE SPAN TO THE PIER WITH THE LEAF IN THE CLOSED POSITION IS ACCOMPLISHED THROUGH HEAVY STEEL SHOES ATTACHED TO THE SPAN THAT ENGAGE COMPANION PIECES, CALLED STRIKE PLATES OR BASES, MOUNTED ON THE PIER.

LIVE LOAD SHOES ARE NORMALLY ATTACHED TO THE LOWER FLANGE OF THE BASCULE GIRDERS, SO THAT FOR EVERY GIRDER THERE IS A LIVE LOAD SHOE. OFTEN THE SHOE WILL HAVE A CONVEX SURFACE SO THAT LINE CONTACT IS POSSIBLE WITH THE STRIKE PLATE.

FOR LIVE LOAD SHOES TO DO THEIR JOB PROPERLY THE SHOE AND

STRIKE PLATE MUST BE IN FIRM CONTACT WHEN THE LEAF IS CLOSED. ADJUSTMENT IS USUALLY ACCOMPLISHED BY SHIMMING ONE OR BOTH MEMBERS. THE PHYSICAL SIZE OF THE LIVE LOAD SHOES IS DEPENDENT UPON THE SIZE OF THE MOVABLE LEAF AND THE MAGNITUDE OF THE LIVE LOADS.

TAIL LOCKS

IN MOST CASES TAIL LOCKS ARE PROVIDED ONLY TO RESIST ANY TENDENCY OF THE MOVABLE SPAN TO ROTATE IN THE OPENING DIRECTION WHEN THE SPAN IS IN THE CLOSED POSITION, PARTICULARLY DURING THE PASSAGE OF TRAFFIC.

COMMON TYPES OF TAIL LOCKS INCLUDE BAR LOCKS THAT ARE INSERTED INTO A RECEIVER LOCATED IN THE COUNTERWEIGHT OR A SUPPORT OR PROP POSITIONED BENEATH THE COUNTERWEIGHT AFTER THE BRIDGE IS CLOSED.

TAIL LOCKS ARE NOT ALWAYS NECESSARY SINCE, IF THERE IS NO TENDENCY FOR THE STRUCTURE TO ROTATE IN THE DIRECTION OF OPENING THEY WOULD SERVE NO USEFUL PURPOSE. THUS THE DESIGN OF THE BRIDGE, THAT IS, THE LOCATION OF THE ROAD BREAK WITH RESPECT TO THE TRUNNIONS' CENTER LINE DETERMINES THE NEED FOR TAIL LOCKS.

ANCHORAGES

NO DOUBT THIS TERM DERIVES FROM THE ANCHORAGE REQUIRED ON CANTILEVER FIXED SPANS SINCE UNDER LIVE LOAD A TRUNNION BASCULE ACTS SIMILARLY TO SUCH A SPAN.

THE ANCHORAGES CONSIST OF ANCHOR LUGS OR PLATES ATTACHED TO THE COUNTERWEIGHT WHICH ENGAGE SEATS IN THE ANCHOR COLUMNS SECURED TO THE PIERS.

WE SHALL LOOK AT TWO CASES OF BASCULE LEAFS; ONE WHERE THE LIVE LOAD IS ENTERED ON THE APPROACH SIDE OF THE TRUNNION AND THE OTHER WHERE THE LIVE LOAD IS ENTERED ON THE CHANNEL SIDE.

THE FIRST OF THESE IS SHOWN ON SCHEMATIC DRAWING, (FIG 1). NOTICE THAT ALL THE ELEMENTS PREVIOUSLY MENTIONED ARE PRESENT - SPAN AND TAIL LOCKS, LIVE LOAD SHOES, ANCHORAGES AND BRAKES IN THE MACHINERY TRAIN (NOT SHOWN IN THIS SKETCH). NOTICE ALSO THE ROAD BREAK IS AWAY FROM THE CHANNEL, ON THE APPROACH SIDE OF THE TRUNNIONS' CENTERLINE.

IDEALLY IT IS DESIREABLE TO PRECLUDE THE APPLICATION OF LIVE LOADS TO THE TRUNNION BEARINGS. THIS IS IMPOSSIBLE TO DO IN THIS DESIGN; THEREFORE, EFFORTS ARE MADE TO REDUCE THE MAGNITUDE AND FREQUENCY OF SHOCK LOADS TO THE TRUNNION BEARINGS SINCE THE INEVITABLE RESULT WILL BE BEARING FAILURE AND IN SOME CASES DISTRESS AND DAMAGE TO THE TRUNNION BEARING SUPPORT STRUCTURES.

NOW, WHAT OCCURS AS LIVE LOAD COMES UPON THE MOVABLE SPAN ? (FOR OUR DISCUSSIONS WE SHALL ASSUME THE SPAN IS BALANCED SO THAT THE CENTER OF GRAVITY OF THE MOVABLE STRUCTURE LIES ON THE TRUNNIONS' CENTERLINE)

AT POSITION Z1 THE VERTICAL LOAD IS SUPPORTED PROPORTIONATELY BY THE TAIL LOCKS AND THE TRUNNION BEARINGS. ANY COUNTERCLOCKWISE ROTATION OF THE SPAN THAT MIGHT OCCUR DUE TO EXCESSIVE CLEARANCE IN THE TAIL LOCKS IS RESISTED BY THE BRAKES THROUGH THE MACHINERY TRAIN TO THE CONTACT AT THE RACK AND RACK PINION. ADDITIONALLY THE SPAN LOCKS OFFER RESISTANCE TO SUCH ROTATION.

AS THE LOAD PROCEEDS FURTHER TOWARD THE CHANNEL TO POSITION Z2 THE VERTICAL LOAD IS NOW SUPPORTED BY THE TRUNNION BEARINGS AND THE LIVE LOAD SHOES. ANY CLOCKWISE ROTATION OF THE SPAN WILL FINALLY BE RESISTED AND STOPPED BY THE LIVE LOAD SHOES, ANCHORAGES, SPAN LOCKS AND BRAKES - EITHER EITHER INDIVIDUALLY OR WITH TWO OR MORE ACTING TOGETHER.

FURTHER PROGRESS OF THE LIVE LOAD TO POSITION Z3 REMOVES ALL LIVE LOAD FROM THE TRUNNION BEARINGS. IN FACT, HOOL AND KINNE IN THEIR BOOK, "MOVABLE AND LONG SPAN BRIDGES", HAVE SUGGESTED THE SPAN IS NOW ACTING LIKE A CANTILEVER SPAN UNDER LIVE LOAD, BEING SUPPORTED AT THE LIVE LOAD SHOES AND ANCHORED BY THE COUNTERWEIGHT ANCHORAGES. THUS THE VERTICAL LOAD IS SUPPORTED BY THE LIVE LOAD SHOES, WHICH ARE ADJUSTED BY SHIMS TO COME TO BEARING SLIGHTLY BEFORE THE ANCHOR LUGS ENGAGE SO THAT THE TRUNNIONS LIFT A SMALL AMOUNT AND REMOVE SOME OF THE DEAD LOAD FROM THE TRUNNION BEARINS AND THEIR SUPPORTS. THE SPAN LOCKS ASSURE UNIFORM DEFLECTION OF THE TIPS OF THE LEAFS THROUGH THE TRANSFER OF SHEAR LOADS FROM ONE LEAF TO THE OTHER.

THE STABILITY OF THE SPAN IN THE CLOSED POSITION DEPENDS UPON THE PROPER FUNCTIONING OF EACH MEMBER OF THE SYSTEM INDIVIDUALLY AS WELL AS IN CONCERT WITH OTHER MEMBERS OF THE SYSTEM.

TO FUNCTION CORRECTLY THE MEMBERS MUST BE INSTALLED AND ADJUSTED PROPERLY AND THEN MAINTAINED IN THAT MANNER. THIS IS NOT A DIFFICULT JOB BUT ONE THAT REQUIRES REGULAR ATTENTION.

NORMALLY THE ENGINEER WILL DESIGNATE THE PROPER ADJUSTMENTS AND CLEARANCES ON THE DESIGN DRAWINGS. IF THESE DOCUMENTS ARE NOT AVAILABLE THOSE RESPONSIBLE FOR MAINTAINING THE INSTALLATION MUST USE THEIR BEST JUDGEMENT IN ESTABLISHING SATISFACTORY SETTINGS.

THE FOLLOWING PROCEEDURE IS OFFERED AS A SUGGESTED GUIDELINE FOR SETTING AND ADJUSTING THE COMPONENTS OF THE STABILIZING SYSTEM:

NOTE : ALL SETTINGS AND ADJUSTMENTS ARE MADE WITH THE SPAN IN THE CLOSED POSITION

1. CLOSE THE SPAN BUT DO NOT INSERT THE SPAN AND TAIL LOCKS AND DO NOT SET THE BRAKES.
2. WITH ALL LIVE LOAD SHOES IN FIRM CONTACT SHIM THEM TO ACHIEVE .025/.035 VERTICAL CLEARANCE BETWEEN THE ANCHOR LUG AND SEAT.
3. ADJUST THE SPAN LOCKS TO ACHIEVE .010 MAXIMUM, TOTAL VERTICAL CLEARANCE BETWEEN THE BAR AND RECEIVER.
4. ADJUST THE TAIL LOCKS SO THAT THERE IS A MAXIMUM TOTAL POSSIBLE MOVEMENT OF .010 IN THE DIRECTION OF SPAN OPENING. THERE IS NO NEED FOR THE TAIL LOCKS TO RESTRICT SPAN MOVEMENT IN THE DIRECTION OF CLOSING.
5. INSPECT THE BRAKES TO ASSURE THEY ARE COMPLETELY SET WHEN THEY ARE ELECTRICALLY DE-ENERGIZED.

NOT ALL BRIDGES HAVE ALL OF THE COMPONENTS LISTED ABOVE; THEREFORE, THE PROCEEDURE WOULD BE MODIFIED TO SUIT THE DEMANDS OF THAT PARTICULAR DESIGN.

OFTEN DURING THE LIFE OF A BRIDGE THESE DEVICES BECOME WORN, GET OUT OF ADJUSTMENT OR ARE INTENTIONALLY OR INADVERTENTLY REMOVED AND DISCARDED. THE STABILIZING SYSTEM THEN IS "LOOSE" AND NO LONGER ABLE TO FULFILL ITS PURPOSE RELIABLY. AS A RESULT EXCESSIVE SHOCK LOADS ARE APPLIED TO THE TRUNNION BEARINGS, THE RACKS, PINIONS AND OTHER MACHINERY AS WELL AS TO THE STABILIZING MEMBERS THEMSELVES. WITH SUFFICIENT REPITITION FAILURES OCCUR.

WHEN THE BRIDGE IS IN THE CLOSED POSITION AND THE BRAKES ARE SET THE SECOND TOOTH FROM THE END OF THE RACK IS POSITIONED

BETWEEN TWO PINION TEETH. THE FACES OF THE RACK AND PINION TEETH ENGAGED WHILE CLOSING THE LEAF SHOULD BE IN FIRM CONTACT. NOW, IF THE TAIL LOCKS AND LIVE LOAD SHOES ARE IMPROPERLY ADJUSTED SO THE SPAN IS PERMITTED TO ROTATE BACK AND FORTH DURING THE PASSAGE OF LIVE LOAD FROM ONE SIDE OF THE TRUNNION CENTERLINE TO THE OTHER, HIGH SHOCK LOADS ARE GOING TO BE PRESENT AT THE ADJACENT RACK AND PINION TEETH. TOTAL ROTATION OF THE SPAN NECESSARY TO PERMIT HARD BANGING TOGETHER OF THE RACK AND PINION TEETH IS SOMETHING IN THE ORDER OF .05 DEGREES. NOT VERY MUCH ! THE FREQUENCY OF OCCURENCE CAN BE MANY TIMES A MINUTE ON HEAVILY TRAVELED BRIDGES. THE RESULT ? FAILURE OF THE RACK AND/OR PINION TEETH - AND FAIL THEY DO AS THE PHOTOGRAPH ILLUSTRATES.

ANOTHER EQUALLY, IF NOT EVEN MORE, SERIOUS RESULT IS FRACTURE AND FAILURE OF THE TRUNNION BEARING. THE PRINCIPAL CULPRITS HERE ARE THE LIVE LOAD SHOES AND ANCHORAGES. THAT IS - PROPER ADJUSTMENT OF THEM.

CONSIDERING THE LEAF A CANTILEVER SPAN WHEN THE LIVE LOAD IS BETWEEN THE LIVE LOAD SHOES AND LEAF TIP IT IS SEEN THAT IF THE LIVE LOAD SHOES AND ANCHORAGES ARE ADJUSTED SO THAT NO CLEARANCE, OR WORSE - PRELOAD, EXISTS BEFORE THE APPLICATION OF LIVE LOAD THEN THE TRUNNION BEARING IS NOT RELIEVED AND CAN BECOME SUBJECTED TO HIGH SHOCK LOADS AS THE TRAFFIC CROSSES. THE FAILURE OF THE TRUNNION BEARING IN THIS PHOTOGRAPH IS THE RESULT OF IMPROPER LIVE LOAD SHOE AND ANCHORAGE ADJUSTMENT.

THE RESULTS OF THESE SHOCK LOADS ARE NOT LIMITED TO THE TRUNNION BEARINGS, RACKS AND PINIONS, NO; THERE ARE MANY OTHER MANIFESTATIONS. EXCESSIVE VERTICAL CLEARANCE AND PLAY IN THE SPAN LOCKS, BROKEN RACK PINION SHAFT BEARINGS AND DISTORTED RACK PINION SHAFT BEARING MOUNTING BOLTS, TO MENTION A FEW. IN FACT, EVEN STRUCTURAL MEMBERS ARE SUBJECT TO DISTRESS DUE TO FAULTY STABILIZING SYSTEMS.

IF THE LIVE LOAD SHOES ARE NOT IN FIRM CONTACT WITH THEIR STRIKE PLATES THE SHOCK LOADS CAN ULTIMATELY CAUSE THE CONCRETE PIER TO CRACK AND BREAK UP. THIS PHOTOGRAPH ILLUSTRATES A LIVE LOAD SHOE MASONRY SUPPORT THAT HAS BEEN RE-CAPPED TO REPAIR THE RESULTS OF SUCH A PROBLEM. NOTICE THE CAP HAS AGAIN CRACKED. THIS CONDITION WILL PERSIST UNTIL SUCH TIME AS CORRECTIVE MEASURES ARE ACCOMPLISHED TO ELIMINATE THE SHOCK LOADS OCCURING TO THE LIVE LOAD SHOE.

MANY OF THE SHOCK LOADS WE HAVE DISCUSSED ARE THOSE RESULTING

FROM THE SUDDEN CLOCKWISE AND COUNTERCLOCKWISE ROTATION OF THE LEAF AS LIVE LOADS PROCEED FROM ONE SIDE OF THE TRUNNIONS' CENTERLINE TO THE OTHER. NORMALLY THIS CONDITION OCCURS ONLY WHEN THE ROAD BREAK IS AWAY FROM THE CHANNEL SIDE OF THE TRUNNION. ANOTHER DESIGN POSITIONS THE ROAD BREAK SO THAT ONCOMING LIVE LOADS DO NOT INTRODUCE A COUNTERCLOCKWISE MOMENT, THIS IS ILLUSTRATED IN THE SCHEMATIC DRAWING (FIG 2).

ALTHOUGH SOMEWHAT SIMILAR TO THE SYSTEM WE PREVIOUSLY DISCUSSED, NOTICE THE ROAD BREAK IS LOCATED BETWEEN THE TRUNNION CENTERLINE AND THE LIVE LOAD SHOES. SINCE THE COUNTERCLOCKWISE MOMENT IS ELIMINATED THERE IS NO NEED FOR TAIL LOCKS; THEREBY SIMPLIFYING THE DESIGN AND GREATLY EASING THE COMPLICATIONS. OTHER THAN THAT THE SYSTEM IS SIMILAR IN COMPONENTS - LIVE LOAD SHOES, ANCHORAGES, SPAN LOCKS AND BRAKES - AS WELL AS REQUIRED ADJUSTMENTS. OVERALL THIS SYSTEM IS EASIER TO MAINTAIN AND LESS SUSCEPTIBLE TO THE PROBLEMS WE HAVE REVIEWED.

MAINTENANCE OF STABILIZING SYSTEM COMPONENTS IS RELATIVELY STRAIGHTFORWARD AND REASONABLY SIMPLE, ALTHOUGH AT TIMES VERY CUMBERSOME AND INCONVENIENT.

SOMETIMES THE DESIGNER COMES UP WITH MODIFIED SYSTEMS, ONES WHICH DO NOT USE ALL OF THE COMPONENTS SHOWN. FOR INSTANCE, THERE ARE A FEW TRUNNION BASCULE BRIDGES SIMILAR TO THIS SCHEMATIC THAT HAVE NO LIVE SHOES FORWARD OF THE TRUNNION. THUS, ALL MOMENTS, RESULTING FROM LIVE LOADS AND UNBALANCE IN THE CLOSED POSITION, ARE RESISTED AT THE ANCHORAGES AND THE TOTAL DEAD AND LIVE LOADS SUPPORTED BY THE TRUNNION BEARINGS. IN SUCH A DESIGN, THE ANCHORAGES SHOULD BE IN FIRM CONTACT WHEN THE LEAF IS CLOSED AND THE SPAN LOCKS ENGAGED.

MOST BAR TYPE LOCKS HAVE PROVISION TO SHIM THE SHOES IN THE GUIDES AND SOCKETS IN ORDER TO ALIGN THEM AND PROVIDE THE PROPER VERTICAL CLEARANCE WITH THE BAR. JAW TYPE LOCKS USUALLY HAVE AN ECCENTRIC PIN THAT ADJUSTS THE THROW OF THE JAWS TO ACHIEVE CORRECT CLEARANCE IN THE RECEIVER.

LIVE LOAD SHOES AND ANCHORAGES ARE USUALLY ADJUSTED WITH FULL SHIMS BETWEEN THE SHOE AND STRUCTURAL SUPPORT. OFTEN IT IS DIFFICULT TO REMOVE THESE HEAVY STEEL MEMBERS TO INSTALL SHIMS AND SHORTCUTS ARE TAKEN. IN MOST CASES THEY WON'T WORK FOR VERY LONG AS EVIDENCED BY THIS STEEL SHEET WELDED TO THE STRIKE PLATE OF A LIVE LOAD SHOE. ALTHOUGH INSTALLED WITH THE BEST OF INTENTIONS IT DIDN'T HAVE A CHANCE OF SUCCEEDING.

ANOTHER INNOCUOUS PROBLEM ASSOCIATED WITH STATIC STABILIZING SYSTEMS IS THAT FREQUENTLY THOSE CHARGED WITH THE RESPONSIBITY OF MAINTAINING THEM HAVE LITTLE OR NO UNDERSTANDING OF THEIR IMPORTANCE OR PROPER ADJUSTMENT. OFTEN COMPONENTS ARE REMOVED BECAUSE THEY DON'T FUNCTION PROPERLY, OR BECAUSE THE TENDER HAS DIFFICULTY CLOSING THE SPAN; WITHOUT REGARD TO THE POTENTIAL DAMAGE THAT WILL PROBABLY RESULT.

THOSE RESPONSIBLE FOR RELIABLE OPERATION AND MAINTENANCE OF THESE BRIDGES SHOULD BE ENCOURAGED TO GAIN A THOROUGH UNDERSTANDING OF THE STABILIZING SYSTEMS USED ON THEIR STRUCTURES AND TO IMPLEMENT PROGRAMS TO INSURE THEY ARE MAINTAINED AS REQUIRED.

THE BOTTOM LINE IS - YOU'LL SAVE A LOT OF MAINTENENCE DOLLARS, HAVE FEWER EMERGENCY CALLS AND GET MORE SLEEP.

REFERENCES :

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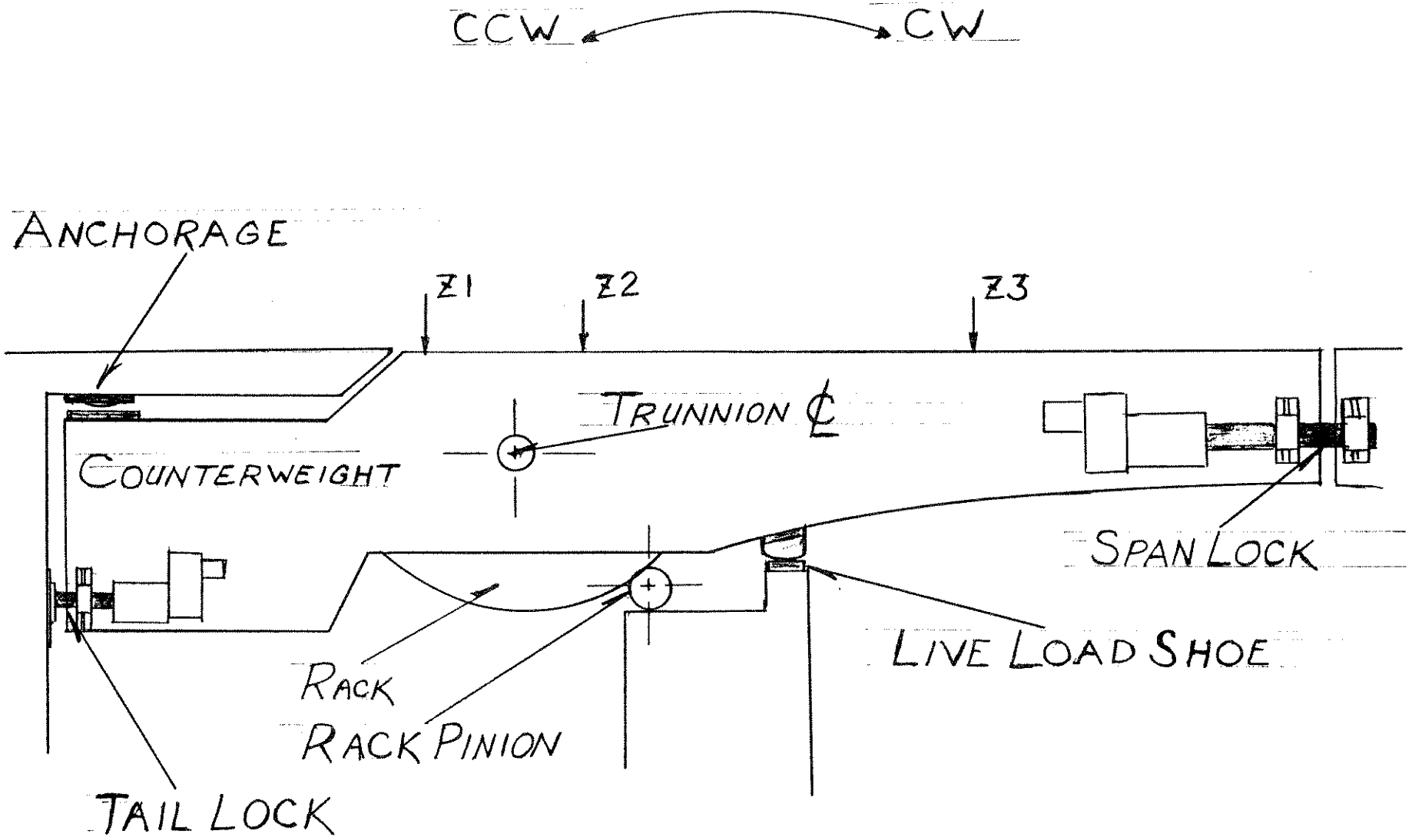
CCW
CW
ANCHORAGE
Z1
Z2
Z3
TRUNNION ℄
COUNTERWEIGHT
SPAN LOCK
LIVE LOAD SHOE
RACK
RACK PINION
TAIL LOCK

FIG. 1

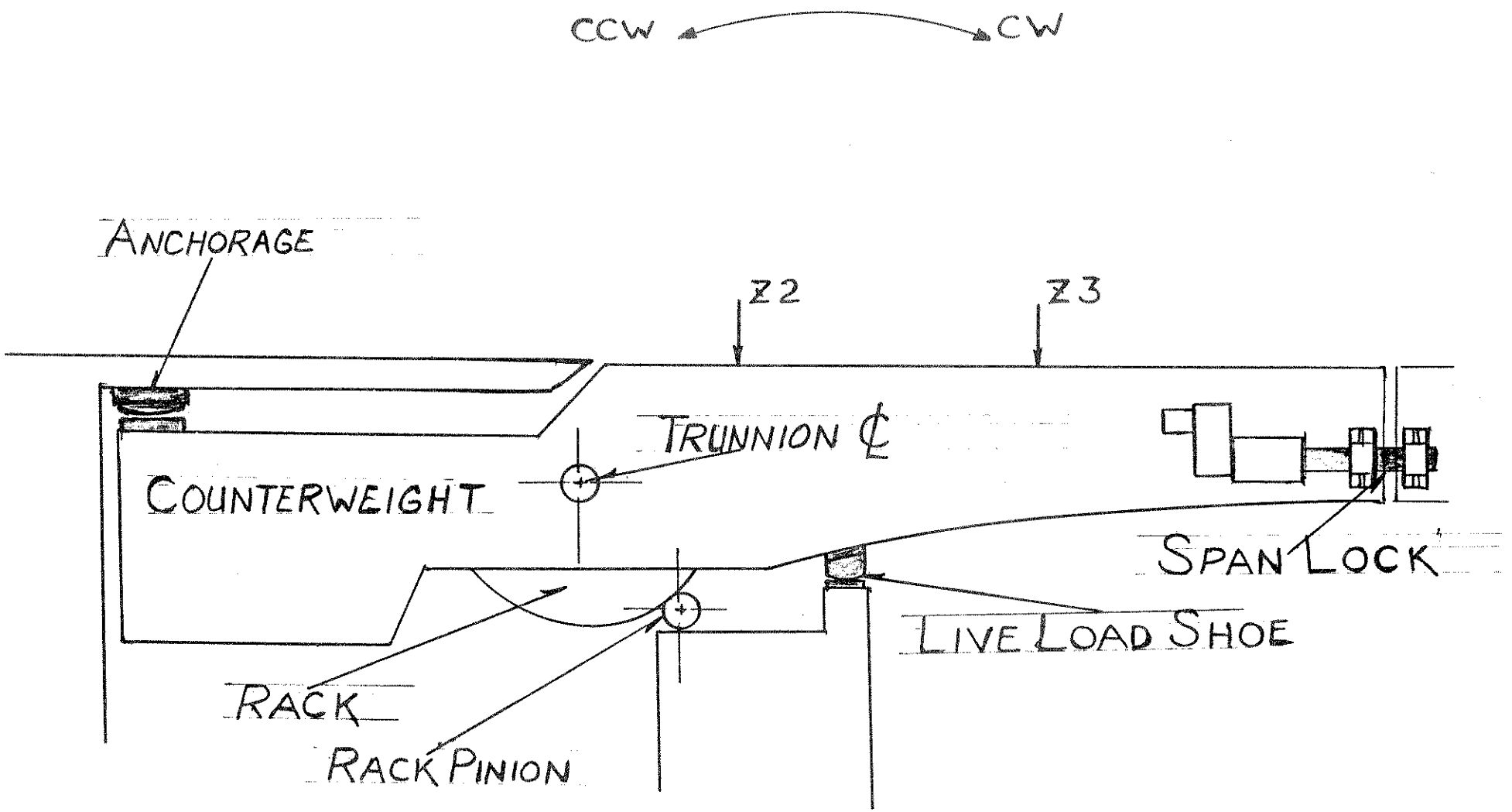
CCW
CW
ANCHORAGE
Z2
Z3
TRUNNION ℄
COUNTERWEIGHT
SPAN LOCK
LIVE LOAD SHOE
RACK
RACK PINION

FIG. 2