CHAPTER 7: RAILWAY AND HIGHWAY ENGINEERING

RAILWAY ENGINEERING

543. Three passenger trains on line for special use toppled over at the Tangshan Rolling Stock Plant. (Photo: Lu Yaoyong)
544. Jingshan line K248+150 (intensity rating IX), passenger train No. 40 derailed, the diesel locomotive caught fire, and rails were locally bent. (Photos: Chen Dasheng)
A goods train derailed and an oil tank toppled over on Jingshan line in the vicinity of K244+100 (intensity rating IX). (Photos: Chen Dasheng)
546. The photos to the left and below show four sections of the traveling oil tank train No. 041 that toppled over on Jingshan line in the vicinity of K221+100 (intensity rating IX).
547. The running train No. 1020 at the Lutai Railway Station on Jingshan line K219+700 (intensity rating IX) derailed and the rail broke off.

548. The running trains No. 117 derailed on the Jingshan line in the vicinity of K201+000 (intensity rating VII).
549. A section of continuous rail was seriously bent on Jingshan line. (Photo: Scientific Research Institute of Railways)

550. The continuous rail was horizontally bent on Jingshan line K312+250 (intensity rating IX). (Photo: Zhang Naiheng)
551. The road bed cracked and subsided and the rail was horizontally bent on the Jingshan line K308+450 (intensity rating VIII). (Photo: Zhang Naiheng)

552. The rail was bent horizontally at K246+350 in the intensity IX region along the Beijing-Shanhaiguan (Jingshan line) Railroad. (Photo: Chen Dasheng)
553. The rail track was bent horizontally near a culvert in the vicinity of K244 (intensity rating IX) on the Jingshan line. (Photo: Chen Dasheng)

554. There were sand boils and waterspouts in many locations and the rail bent horizontally at the Lutai Railway Station on Jingshan line K219+700 (intensity rating IX).
555. The rail track bent horizontally at K192+000 (intensity rating VII) on the Jingshan line.

556. The rail track bent horizontally on the Nanbao line for special use K11+020 (intensity rating VIII).
557. The ground loosened and the rail bent horizontally on the Nanbao line for special use K10+730 (intensity rating VIII).

558. The embankment subsided and the rail bent on the Tongtuo up line in the vicinity of K0+400 (intensity rating IX).
559. The road bed and rail was deformed on the Tongtuo up line (intensity rating IX).
(Photo: Institute of Geology, State Seismological Bureau)

560. The road bed subsided and the rail was seriously deformed on the Tongtuo up line K1+900 (intensity rating IX).
561. An embankment subsided and the rail was deformed on the Tongtuo up line (intensity rating IX).

562. At an excavated area of a man-made lake at the Tangshan Mine, Coal Mine Bureau of Kailuan, rails slipped and were deformed. (Photo: Chen Dasheng)
563. The road bed subsided and the rail bent on the Gu-Lu Fan Railway on the line for special use at the Coal Mine Bureau of Kailuan. (Photo: Coal Mine Bureau of Kailuan)

564. The ground was dense and stable and the rails were basically intact in the meizoseismal area (intensity XI) in the city of Tangshan.
565. The road bed was firm and the rail was basically intact at the Xugezhuang Station on the Jingshan line K254+800 (intensity rating X).

566. Limestone roadbed and the rail were intact on the Tongtuo up line K0+930-K1-360 (intensity rating IX).
567. The roadbed was saturated silt and a fine sand and the embankment subsided up to 3 m on the Jingshan line in the vicinity of K282+000 (intensity rating X).

568. Longitudinal fissures occurred along the road bed on Jingshan line in the vicinity of K250+500 (intensity rating IX).
569. The photo shows longitudinal fissures which were found along the road bed on Jingshan line in the vicinity of K191-K192 (intensity rating VIII).

570. At an 8 m span of reinforced concrete beam bridge on the Tongtuo up line K2+945 (intensity rating IX), the right embankment at the end of the bridge subsided and the rail hung in the air.
571. On the Tongtuo up line K2+600 (intensity rating IX), an embankment at the end of a 23.8 m span pre-stressed concrete beam bridge subsided 3 m.

572. On the Tongtuo up line (intensity rating IX), an embankment at the end of a bridge subsided and the facing of the slope was damaged.
573. The end of a railway bridge subsided and the rails hung in the air north of Shezhuang Village, Luanxian County. (Photo: Seismo-geological Brigade, State Seismological Bureau)

574. The up line bridge of the Ji Canal on Jinshan line K210+827 (intensity rating IX), had two 20 m spans of top supported plate girders shown at the right side of the photo, two 62.8 m spans of bottom supported trusses, an open caisson base and the ground was silty-sandy clay. The open caissons of the bridge pier No. 1 and No. 3 were shallower than No. 2. Bridge pier No. 1 and No. 3 relative to No. 2 subsided 0.68 m and 0.57 m. The bridge was impassable to traffic.
575a. Ground deformation at Ji Canal on Jingshan line shortened 2.31 m and the rail on the embankment on the end of the bridge on the Beijing side bent.

575b. The rail on the bridge floor became a broken line.
Bridge pier No. 1 (above) and bridge pier No. 3 (right) of Ji Canal on the Jingshan line each moved 2.0 m towards the center of the river.
577. On the Jingshan line the gravity abutment on the Shanhaiguan side slipped towards the center of the river. The plate girder bearing was damaged and the end of the girder stood up to the back wall of the abutment.

578. The down line bridge of the Ji Canal on Jingshan line K210+827 (intensity rating IX) was built with one 8.0 m span of an I-shaped beam, two 9.7 m spans of top supported plate girders, two 62.8 m spans of bottom supported trusses, one 15.7 m span of a top supported plate girder, a wood pile base and the ground was of a silty-sandy clay. The length of the ground deformation shortened 2.37 m and the rail track on the bridge floor was pressed and bent.
579. The concrete bridge piers of the down line bridge of the Ji Canal were broken off. The photo below is a close-up view of broken bridge pier No. 2.
(Photos: Chen Dasheng and Liao Shuqiao)
580. The rails were seriously bent at the end of the down line bridge of the Ji Canal on the Beijing side.

581a. On the down line bridge of the Ji Canal, the gravitational style abutment on the Shanhaiguan side slipped toward the center of the river roughly 1.6 m.
581b. The steel girder separated from the abutment on the Beijing side.

582. The up line bridge of the Yongding New River on Jingshan line K194+048 (intensity rating IV) had a series of 20-23.8 m spans of prestressed concrete beams. The ground was soft plastic sandy clay. The foundation had drill hole piles. After the earthquake there was no apparent change in the elevation of the supports.
583. On the up line bridge of the Yongding New River in the vicinity of bridge pier No. 13, the flood land displaced and cracked.

584. The bridge pier No. 13 displaced and the rocker shaft of movable bearings dislocated.
585. The abutment was displaced and an anchor bolt on bridge pier No. 15 was sheared on the up line bridge.

586. The abutment on the Shanhaiguan side of the up line bridge was broken.
587. At the Luanhe Bridge on the Jingshan line (intensity rating IX), the movable bearing on the Shanhaiguan side of the top supported plate girder on the 20th span was tilted. (Photo: Zhang Naiheng)

588. On the Beijing side of the Luanhe Bridge, one anchor bolt bent and the other sheared at the 20th span of the up line. (Photo: Zhang Naiheng)
589. At the Tongtuo up line K3+157 (intensity rating IX), one 8.0 m span of reinforced concrete beam sideways 0.5-1.2 m.

590. On the Tongtuo up line K2+704 (intensity rating IX), a 23.8 m span of a prestressed concrete beam bridge was displaced to the curved side 0.5 m.
591. On the Tongtuo up line K2+271 (intensity rating IX), one beam of a 12.0 m span of a reinforced concrete beam bridge was transversely displaced 75 cm.
On the Tongtuo up line K2+600 (intensity rating IX), a 23.8 m span of a prestressed concrete beam bridge located on a circular arc of R=600 m, the curved external side beam fell into the river (above). The photo to the right is a profile view. The foundation material was saturated silt and fine sand. (Photos: Liao Shuqiao and Chen Dasheng)
593a. The Douhe River Bridge on Tangzun line K2+955 (intensity rating X), had three 16.0 m spans of reinforced concrete beams. The ground was saturated silt and fine sand. The distance between abutments was shortened 3.70 m and the plain concrete abutment and bridge piers were sheared. (Photos: Liao Shuqiao and Xu Changjiang)
593b. The photos on this page are close-up views of the sheared abutment and bridge piers.
594. On Jingshan line K266+926 (intensity rating IX) there were three 19.0 m spans of a top supported plate girder bridge. Before the earthquake the neighboring ends of the spans were connected by steel plates.

595. Before the earthquake on Jingshan line K255+926, a Φ26 round reinforcing bar was connected to the two adjacent rings to prevent separation. After the earthquake the reinforcing bar was pulled off and broken. See Photo 596 for an example. (Photo: Liu Chun)
Before the earthquake, at the up line bridge of Yongding New River on Jingshan line K194+048 (intensity rating VII), rings at the adjoining beam ends were connected by double $\Phi 26$ reinforcing bars to prevent separation (above). The concrete at the ends of the beam was cracked and broken (below).
597. Two 6.0 m spans of reinforced concrete slabs over trunk culverts were intact after the earthquake at the Yonghong tunnel bridge in the city of Tangshan (intensity rating XI).

598. Two 4.0 m spans over reinforced concrete trunk culverts were intact after the earthquake on Jingshan line K255+000 (intensity rating X).
599a. A close-up view of a wood canopy at the Tangshan Railway Station which remained intact.

599b. Another view of the wood canopy at the Tangshan Railway Station.
600. A platform bridge constructed of steel at the Tangshan Railway Station was intact.

601. In the city of Tangshan, the retaining wall of the Yonghong tunnel bridge was intact.
602. A retaining wall on Jingshan line K267+334 (intensity rating X), which was constructed of schist blocks tilted outward. The maximum displacement was up to 20 cm.

(Photos without credits in this section have been supplied by Liao Shuqiao)
603. An aerial photograph showing the Shengli Bridge in the city of Tangshan. The riverbank and the abutment moved toward the center of the river. A span on the western end collapsed. See photo 610. (Photo: Zhou Xuegong)
604. The photo above shows fractured and displaced pavement 200 m long with a maximum width of up to 3 m on the western end of Shengli Bridge in the city of Tangshan. (Photo: Earthquake Research Institute, SSB)

605. The photo shows a fractured pavement band along the highway from the city of Tangshan to Daodizhen. (Photo: Chen Dasheng)
606. A network of ground fissures on the highway at Mengzhuang, Xigezhuang Commune, Fengnan County. (Photo: Chen Dasheng)

607. A ground fissure band along the highway in the vicinity of Laoyuying in the southern portion of Luanxian County was roughly 30 m long and 8 m wide. The width of a single fissure was up to 1 meter and 1.5 m in visible depth. The general strike was in an east-west direction. (Photo: Institute of Geology, State Seismological Bureau)
608. There were longitudinal fissures on the highway road surface in the vicinity of Bachigang, Luanan County. (Photo: Institute of Geology, State Seismological Bureau)

609. The wheels of a truck got stuck in a ground fissure on the edge of the highway at Fuzhuang, Hangu District in the city of Tianjin. (Photo: Yu Zeliang)
610. Shengli Bridge in the city of Tangshan had five spans. The piers were poured concrete piles of dual-column style. The bridge was skewed 15° from west to east. Pier No. 4 collapsed. (Photo: Earthquake Research Institute, State Seismological Bureau)

611. In the city of Tangshan, relative displacement occurred at Quzhuang Bridge between the bridge floor and abutment. (Photo: Xu Changjiang)
612. Bridge piers tilted at the July the First Bridge at the Tangshan Power Plant. (Photo: Qi Yongquan)

613. The bottom of Pier No. 1 cracked approximately 15 cm at Dazhong Bridge in the city of Tangshan. (Photo: Xu Changjiang)
614. Piers tilted and column caps dislocated at the Nuzhizhai Bridge in the city of Tangshan.  
(Photo: Xu Fengyun)

615. The Yuehe Bridge in the city of Tangshan had poured piles and simple beams. The  
bank slopes slipped toward the center of the river and the bridge piers tilted.  
(Photo: Xu Fengyun)
616. The left abutment slipped toward the center of the river on a small wooden bridge at the Tangshan Tap Water Company. (Photo: Xu Changjiang)

617. The five spans 10.6 m each of the power plant bridge of the Tangshan Iron and Steel Company had a wooden pile base. Above the piles there were reinforced concrete piers which remained intact after the earthquake. (Photo: Xu Changjiang)
618. At Chengzizhuang in the city of Tangshan, a bridge with 17 spans constructed of rectangular stone blocks was intact after the earthquake. (Photo: Xu Changjiang)

619. Xiyao Bridge in the city of Tangshan was slightly damaged. It had a wooden pile base, a plain concrete abutment and pier, and two spans of a continuous beam. (Photo: Xu Changjiang)
620. Daodicun Bridge in Fengnan County had two spans collapse. (Photo: Seismo-geological Brigade, State Seismological Bureau)

621. One span collapsed at the Shahe River Highway Bridge in Leizhuang County. (Photo: Earthquake Research Institute, State Seismological Bureau)
622. The village bridge in Luanxian County collapsed. (Photo: Qi Yongquan)

623a. The Luanhe River Highway Bridge in Luanxian County, which was 600 meters in length and approximately 8 meters in width, collapsed during the earthquake. (Photos: Institute of Geology, State Seismological Bureau)
623b. An aerial photo of the Luanhe River Highway Bridge after the earthquake.  
(Photo: Zhou Xuegong)

624. An aerial view of the Luanhe River Highway Bridge after the earthquake.  
(Photo: Zhou Xuegong)

625. A close-up view of the fourth damaged opening of the Luanhe River Highway Bridge.  
(Photo: Li Fusheng)
626. A close-up view of the fifth damaged span of the Luanhe River Highway Bridge. (Photo: Li Fusheng)

627. A close-up view of the sixth damaged span of the Luanhe River Highway Bridge. (Photo: Li Fusheng)
628. A close-up view of the tenth damaged opening of the Luanhe River Highway Bridge.  
(Photo: Li Fusheng)

629. A close-up view of the eleventh damaged span of the Luanhe River Highway Bridge.  
(Photo: Li Fusheng)
630. A full view of the eleven openings of the Luanhe River Highway Bridge taken from the eastern bank. (Photo: Xu Fengyun)

631a. Pier No. 10 broke off at the Luanhe River Highway Bridge at Zhuacun, Qianan County in the photo above. (Photos: Chen Dasheng)
631b. In the photo to the left the beams of the No. 10 and 11 spans collapsed and the cap of the No. 10 pier fell to the bridge floor of the eleventh opening.

632. A beam fell at the Wangtucun flood way bridge in Luannan County. (Photo: Chen Dasheng)
633. The pier tilted and a side of the contact of the pier cap and bridge surface separated at the Ji Canal Highway Bridge in Hangu District in the city of Tianjin. (Photo: Yu Zeliang)

634. The Lutai Bridge at Hangu in the city of Tianjin was 176 m total in length and 54 m of the tied arch in the middle portion collapsed. (Photo: Institute of Geology, State Seismological Bureau)
635. The floor of the Lutai Bridge dislocated in a transverse direction.

(Photo: Chen Dasheng)
636. The expansion joint pulled apart (left) and compressed (below) at the Lutai Bridge.
(Photo: Chen Dasheng)
637. The Red Banner Bridge at Yeli in the city of Tangshan which collapsed after the earthquake was a single opening reinforced concrete double-curved arch bridge with 36 m of span. (Photo: Xu Changjiang)

638. The single span 40 m Liuguantun double-curved arch bridge collapsed. (Photo: Xu Changjiang)
639. There was no damage at the Zhaogezhuang Bridge in the east coal mine area in the city of Tangshan. The 36 m single opening double-curved arch bridge with a rock base remained basically intact. (Photo: Cui Fuwen)

640. In the suburbs of Tangshan, the Houtun stone arch bridge was slightly damaged. (Photo: Xu Changjiang)
At the Shimen stone arch bridge in Lulong County, a stone of the main arch was displaced at the left and joint between the small arch and the supporting column was displaced. (Photo: Gao Jinying)