

## The Classification of the Flood Damaged Pipeline Identification and Prevention Measures

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### Abstract

In the recent geological disasters damaged pipeline as the research background. This text is on the basis of today's scholars, and systematically give flood disaster of pipeline a definition. At the same time, according to the causes of the damaged pipeline, the pipeline crossing location, topography, formation mechanism and characteristics, as well as the size of the damaged pipeline, the flood disaster of pipeline are classified in detail. Finally, the flood disaster prevention and control measures of pipeline also combined with the actual engineering situation.

### Keywords

Flood Damaged Pipeline, Flood Disaster Prevention, Classification of Flood.

### 1. The research background and current situation of the damaged pipeline by flood

Pipeline transportation has always been an important way of energy transportation in the world. And It is also the main way to transport oil and natural gas in our country. Pipeline transportation has the characteristics of safety, stability, high efficiency and economy and is one of the five major modes of transport. In our country, oil and gas pipeline has 50 years of development history. The pattern of oil and gas pipeline network transmission has been initially formed. Because of China's oil and gas resources distribution has the characteristics of concentrated, uneven, oil and gas pipelines in our country appears local highly concentrated, the national network of transportation.



Fig.1 Chongqing petrochemical landslide and pipeline crack



Fig.2 A damaged site

The damaged pipeline disaster in the long-distance pipeline development is very common, is the largest number, the most common geological distribution. According to the China southwest pipeline company under the jurisdiction of geological disasters along the pipeline in statistics of flood disaster accounted for more than 65%, and each damaged at different degree of development. It caused great economic losses and environmental pollution. Flood disaster of pipeline causes are due to precipitation. For example, local rainfall in 2016 6 since the end of the month, China's pipeline has brought huge damage, leading to multiple crack long pipeline. According to Xinhua News Agency reported in June 30, 2016, Due to the impact of heavy rain and landslides, in Chongqing Nan'an, a Sinopec oil pipeline was ripping, and it diesel spill. Oil has been flowing into the waters of the Yangtze River (Fig.1). In July 5, 6, 2016, Heavy rain all over the country, in ShuiFu, Natural gas pipelines are exposed to more than 400 meters in the visible range. There are 3 retaining wall along natural gas pipeline was destroyed, 18 pipes exposed pipes due to floods, causing direct economic losses of 12609 thousand yuan.

We can see that the flood disaster is frequent geological disasters along the pipeline, and a huge impact. Economy and people are badly damaged.

## **2. The definition of the damaged pipeline by flood**

### **2.1 The definition of the damaged by flood**

Usually, In the classification of geological hazards, flood disaster caused by hydrological phenomena. In particular, it is the change of soil form, character, structure form or structure of the structure caused by the change of water quantity. For example, the building foundation, buried piping and water conservancy facilities were destroyed by the flood damaged. Flood erosion and so on. The generalized definition of the flood damaged is all damage caused by direct or indirect effects of flood. However, the narrow definition of the flood damaged is only damage caused by direct effects of flood.

### **2.2 The definition of the damaged pipeline by flood**

Specific to the destruction of geological disaster damaged pipeline occurred in the pipeline, usually due to direct or indirect effects of water pipeline, the failure process of soil structure and pipeline pipeline caused by the stress changes caused by exposure, moving, bending, cracking etc.

## **3. The classification of the damaged pipeline by flood**

### **3.1 Divided by the damaged pipeline disaster reason**

According to that how to damage pipeline can be divided into direct flood disaster cause damage and induced damage. Direct damage by the flood that form due to pipeline damage directly caused the water seepage or flood. The main forms of damage are gully, collapse, cavity and so on. It can lead to the development of the model of pipe-soil mass, which is from the original equilibrium state, which is not balanced, which leads to the relative movement of soil and pipeline. And it causes the internal stress of the pipe to be rearranged. Finally, large deformation and large displacement of the pipeline are harmful to the safety of oil and gas transportation. The induced water refers to water as a causative factor, the pipeline damage will be long or indirectly caused by the flood disaster in the form. For example, the collapse and debris flow caused by precipitation will make the pipeline damaged. According to the research of identification of damaged pipelines, the main causes of the damaged pipeline including the geology, natural environment and human activities. Water is the most important factor in all the factors, but also the most common.

### **3.2 According to the dynamic medium and the location of the Division**

According to the damaged pipeline dynamic medium and location can be divided into surface water damage and underground water damage. Usually the surface damage occurred in the surface, easy to identify, research in this area is relatively more mature in the study of damaged part. The surface damaged cause pipeline suspended, damage, bending, buckling, and can directly take corresponding measures to rescue. So it is relatively controlled. The underground flood is different from the ground water pipeline is buried underground, so when the pipe is hung, bent and damaged, It's hard for us to

find the damaged area. The underground flood is concealed and revealed the ground behind. So the underground flood is a major factors of a threat to the overall security of pipeline. However, the current domestic research for the occurrence of damaged pipeline underground water damage is relatively small. The causes of the damaged underground basically can be summarized as the effect of groundwater seepage. We can analyze the flow pattern of groundwater and the soil mass. In practical engineering, According to the soil erosion area, underground pipeline damage can be divided into pipeline seepage and pipe flow flood damaged bottom tank. There are many different forms of two kinds of damage. Mainly because the pipeline has damaged pipeline seepage water impermeability, it will prevent soil water flow direction and change the flow direction, but when the flow velocity is smaller, the seepage field is symmetric. Seepage will not take over the soil particles, this will not happen at this time. However, in the larger flow rate ( $Re > 10$ ) cases, it will cause the seepage on the downstream flow field asymmetry, and lead to soil particles with large flow and change of soil around the pipe and the density and distribution, resulting in suspended pipeline disaster. Because the pipe bottom soil and backfill soil is loose, and the effect of soil water, the seepage direction around the pipe laying direction consistent with the pipeline, and the pipe week between the soil and the formation of cracks, resulting in a large area around the pipe soil erosion form hole along the pipeline bead sinkhole, hanging and other hazards. To sum up the main reason affecting the pipeline underground water damage is characteristic of soil water seepage.

### 3.3 According to the pipeline through the terrain to divide

According to the pipeline through the terrain, we can divide the damaged pipeline by flood into the mountains, plains, special relief damage. Pipeline as the most important way to transport oil and natural gas resources, Pipeline needs to be mined from the resources to reach the destination, The pipeline needs to cross the complex situation, and may through the mountains, plains, deserts, rivers and even human activities area, and so on. According to the different environment through the division, we can put forward some strategies for pipeline protection across the terrain, so according to the flood disaster of flood disaster terrain partition pipeline can effectively prevent pipeline under the specific terrain, it plays a very important role.

### 3.4 According to the damage mechanism and damage characteristic of terrain to divide.

According to this rule, we can divide flood damaged pipeline into: slope damage of flood, Platform Field damage of flood, ditches damage of flood . This is the classification of the majority of scholars recognized. For the flood damaged. Numerous studies show that the main reason lies in the formation of the damaged internal and external two categories. Some of the Researchs for water damage identification is divided into geological conditions, natural environment and human activities three, But, In specific aspects, There are two main flood causes is the direct cause and indirect cause. Different flood damage conditions have different emphasis. The all are common method of flood damage recognition now.

Slope damage of the flood (Fig.3): Because the pipeline laying diagonally along the slope, the hydrodynamic effect make the soil move. For a long time to go on like this. It makes the surface of the pipe soil thinning, pipe exposed, bending, hanging. Causes of water damage of slope is that catchment effect leads to the formation of water or soil erosion. It leads to the slope erosion, slope collapse, local slip gully, hydrotechnological protection structure damage. Generally speaking, The main factors of the slope damage of the flood: Slope, slope length, rainfall, rock and soil properties, surface vegetation cover and human engineering activities, laying the situation, etc. The general ways of pipeline laying along the slope: The laying of the cross slope, the laying of the down slope, and the laying Sideway of the slope. Research on the slope damage of the flood show that most slope washout occurred in pipeline along the slope laying situation. Because, in pipeline along the slope laying situation, Pipe trench is also along the slope excavation, then the water and soil flow along the pipeline down the slope direction of the drain, and ultimately it lead to the formation of holes, trap around the pipe. Eventually it evolved into the flood disaster, threatening the safety of the pipeline.



Fig.3 Slope damage of the flood

Platform Field damage of flood (Fig.4) : The fact of the platform damage of flood is that flood causes soil -pipe structure in soil erosion and loss. In other words, Because of dynamic and hydraulic action, leading to the hydraulic erosion, and finally lead to the surrounding soil Loose, holes, sinkhole. Numerous investigations and studies show that: According to Place of damage occurrence, we can divide it into Platform Field collapse, Platform Field sunk. The Platform Field damage of flood main harm is the damage pipeline external platform covering soil thinning, pipeline leakage and suspended. The Platform Field damage of flood serious situation also has a close relationship between the pipeline laying. The main causes of The Platform Field damage: Steep terrain, Pipe trench soil backfill compaction, Strong soil and water seepage, Soil instability, human engineering activities.



Fig.4 Platform Field damage of flood

In summary, The platform field damage of flood and slope damage of flood can be attributed to the slope water erosion problem.

ditches damage of flood (Fig.5) : Ditches damage of flood means that: When the pipeline is laid, the pipeline will cross or along the river bank. Pipeline and soil will be affected by the flow of water in the river. it will makes pipeline suspended, exposed, curved, local buckling and unstable. On usual , The way of long distance pipeline laying and its relationship with the position: Pipeline crossing ditches, Pipeline Striding across ditches, Pipeline laying along the ditches bed, pipeline laying along the river bank slope. Through investigation and analysis, we can find that the swing of long distance pipeline River main dynamic factors of flood damage caused by the erosion of ditches and river swings. The common form of the damaged pipeline in ditches: Pipeline hanging, anti corrosion layer exposed or damaged, and the impact of the pipeline sag or even broken pipe, protective engineering damage. Ditches damage of flood is different from other forms of flood damaged, because the pipeline will be directly affected by the flow of water. So we can focus on how to damage, when we distinguish it. Usually the main form of the impact of water flow under the riverbed, brook road cutting, river bank collapse to silt uplift. The main form of flood hazards pipeline: drift tube, pipe passage, impact, fatigue (vortex vibration).



Fig.5 ditches damage of flood

### 3.5 According to the size of the damaged pipeline of the flood.

According to the size of the damaged pipeline of the flood, we can divide the flood damage into general damage and great damage. The general damage usually means that The influence pipeline length is less than 100 metres and it generally does not cause the pipeline to fail. The great damage maybe cause the pipeline to fail and The influence pipeline length is more than 100 metres. In this way, we divide it , according to water damage consequences.

In short, Long term studies show that Flood disaster of pipeline has the following characteristics: distribution is extensive, but local concentration. Obvious seasonal, concentrated in 5-9 months, and the pipeline along the storm floods have a close relationship. With high frequency of outbreak, destructive, and great harm. When we do the research on the flood damage, We should link up the geological conditions, the natural environment and human activities.

## 4. The prevention of the damaged pipeline requirements and measures

Pay attention to water conservation, starting from the protection of geological soil conditions, solve the necessary conditions of flood ruins. Almost all of the damage is due to soil erosion area, cause pipeline hazard exposure and impending, such as flood and flood to the platform slope is due to slope erosion, the formation of many of the flow path, finally lead to pipeline damage. Therefore, improvement of soil and water conservation measures is the key method to solve the problem of the damaged pipeline.

Focusing on the application of ecological protection and biological measures. For the most effective protection measures of soil and water loss is the biological measures to restore the pipe surface pastures, it can effectively inhibit soil erosion, soil erosion protection can not only prevent soil erosion and mechanical movement, from the loss of reason, loss to the establishment of scientific prevention measures. It Shows that in numerous studies, the most effective method for the damaged pipeline, the highest price is to protect the pipe surface ecological environment, to make full use of grassland plants to soil, biological fixation, artificial activities to ease damage to the surrounding environment.

General pipeline will pass through a large number of complex terrain, such as plain, mountain, plateau, rivers, will also travel through industrial areas, rural areas, etc.. The prevention and control of the damaged pipeline should be adapted to local conditions, combined with the local natural environment, economic situation, human activities to put forward practical measures. We must seek truth from facts, according to local conditions, improve the various terrain conditions, human activities under the conditions of the prevention and control plan and the basis for the prevention and control. To achieve the specific problems encountered in the specific analysis, according to the problem, to solve the problem of scientific and rational.

We should be in advance prevention, focusing on the prevention and control of thinking, In the design stage to be able to consider.

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