

HIGHWAY DESIGN AND ENGINEER IN THE ZONE OF PERMAFROST IN XING'AN MOUNTAINS IN CHINA

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There are masses of permafrost in Xing'an Mountains and the paramos of Qinghai—xi zang plateau. So are sporadic distributions in such areas as Xian Mountain, Er Mountain and Qilian Mountain. Under the condition of annual average temperature bellow 0°C, a layer of earth comes into being which remains the state of freezing for a long period we call it permafrost.

1. Brief introduction

xing'an mountains are located in the northeastern part of china .Owing to the altitude inclined to north, it is very cold in winter, and rainfall is abundant. Each year it begins to freeze at the beginning of October and ice begins to thaw in the follow may the geographical feature of Xing'an Mountains belongs to middle and low hills. The water on the frozen soil layer is abundant. The upper lever is very near the surface of earth. So the surface of earth is over wet. It stagnates water in summer and ice mound. Ice awl takes place in winter. There are a lot of morass distributed in low-lying lands, in gentle slopes and even in the area of even water shed..

2. The influences on highway from poor geographical phenomena.

As the result of existence of permafrost, it is natural that some special poor geographical phenomena take place. Especially when surface of asphalt road is being built, generally we should pay attention to the phenomenon of frost heaving and subsiding caused by water melting due to the melting of ground ice layer.

(1) When building start with road cutting, if the ground ice is exposed to the air, and the upper lever of soil thickness has been lessened artificially, which may cause the around ice to melt and as a result. Heat melting frost heaving (HMFH) take place and various damages will take place.

(2)When building asphalt road surface, if the protection of frozen soil is not given enough attention .the black colored pavement. Which absorbs the most heat, will cause the upper lever of permafrost to subside, especially in the area with high ice content, HMFH may happen, which will damage the surface of road.

(3) During the construction of roads, if earth is taken with improper method or in the place too close to the spot of construction, once the natural cover plants on the road sides are destroyed, such damages as HMFH, roadbed subsiding and side slope slump and crack will take place.

(4) If the earth in the layer of seasonal is melting is much too wet, and water there is too abundant, the

earth on the slopes contains too much water (surpass the liquid limit), under the effect of vehicles and their gravity, earth will slip down along the frozen surface, mud stream and collapse will take place.

3.Deterioration of permafrost in Xing'an Mountains

At present, the permafrost in Xing'an Mountains is in the state of deterioration, most of which is in the shape of island or unconnected permafrost, deterioration generally begins from high place to low place, from sunny slopes to shady slopes, from rough gains of earth to fine ones. Finally the earth will remain in jungle or moors, where the geographical relief is relatively low, and the sunlight is not inclined to reach and conservation of moisture is better.

The general trend of permafrost deterioration determines, the policy that it cannot be the main measure to protect strictly the frozen soil, but it can't be excluded that the principle of frozen soil protection must be applied reasonably.

(1) In the area of connected permafrost, the permafrost layer has in it frozen layer where the ground ice has fully grown or which has high water content, we call this patten as "wet pattern (wp). While we call the frozen layer containing less ice "dry pattern "(DP), for wp section road, after the road has been built, once the melting depth of permafrost increases for some manual elements, and the volume of melting subsiding becomes greater, the stability of road bed can not be guaranteed, so this section is called "strict protection of permafrost "(SPP), for the DP, after the road has been built, though the melting depth of permafrost layer increases a little, but since the melting layer contains less ice, if we can control the volume of melting subsiding, we can still keep the road bed stable. So we call this section PART ALLOWED GRADUALLY MELTING PATTERN (PAGMP)

(2) In the frozen islands of isolated permafrost, for wp, it is so difficult to resist the general trend of the deterioration of natural environment by taking engineering measures, that it is impossible to strictly protect the frozen soil, on the contrary, a good method has still not been found for preventing soil from melting by artificial premelt both technologically and economically, so trying to slow down the speed of melting of frozen soil layer is our principle. And is call non-protected frozen soil pattern, we call the melting area and non-frozen sections in the area of unconnected frozen soil as general seasonal frozen soil.

(3)The division of DP and WP

According to the research on the frozen road bed, with the limitation of the maximum volume of subsiding not beyond 10CM,the maximum water content in permafrost layer can be worked out ,which we use sr to stand for ,when $sr < 0.9$,we call this frozen soil layer DP, $sr \geq 0.9$,we call this wp ,but in the case of the frozen soil thickness on frozen bland less than 5m, $sr < 1.1$ is also used.

4. The road bed design

In general, based on different situation, we follow such principles as protecting or destroying permafrost accordingly in frozen soil sections rich in ice, when both the water content and road standard are high, we are included to follow, the former principle, when the water content is low, and the road bed doesn't subside, we can also follow the latter principle, in frozen soil sections which contain either less ice or more ice, it is allowed to do story the permafrost, and at the same time, the road bed should be designed based to the general method.

(1) Minimum height of embankment

As for SPP, when the wad bed filler is rough grains and the minimum embankment height of asphalt road surface is between 2.4 and 4.0 m, the suggested height of road bed should be limited with in 3m, as for PAGMP, the filler for embankment is also rough grains, and the minimum embankment height of asphalt

road surface is between 2.0m—2.5m, the suggested height of road bed can not exceed is 2.5m, as for non-protective frozen soil pattern, the suggested height is 2cm, and asphalt road surface is not allowed but light grains of sand surface road can slow down ,the melting process largely. For general seasonal frozen soil, the suggested height should not be less than 1.5m, and the design of road should be made according to the general seasonal frozen soil rule.

(2) The protection of berm and foot of slope

For these two frozen soil patterns, SPP and PAGMP, heat protection berm and protective foot should be placed on one side or both sides of the road which can be made from mass, grass skin, Da'tou grass, peat or mud with the root of grass upside ,and with upperst layer of grass being as much soil as possible ,to be pressed into a protective ,slope when the frozen soil layer rich in ice or in soil are close to the base ,(including the changeable base). When the height of embankment is not more than 3m, the height of berm and of foot is not generally less than 0.8m, the width not less than 2m;when the embankment height is more than 3m, the general height of berm and foot should be more than 1m the width not less than 2m

(3) Drainage of roadbed and borrow pit

In order to prevent the upper level of frozen soil layer from dropping as the result of the building of drainage system ,a certain distance should be kept between the drainage system and the wad bed foot, in the section of frozen soil either rich in ice or poor in ice, the distance between the drain ditch and the embankment foot should not be less than 2m, with mud soft clay in moors and damp sections under joining the distance between the drain ditch and embankment foot, shouldn't be less than 8m,in the section of frozen soil , either rich in ice or containing water ,we should try to avoid ,building drain ditch and cut---off ,channels ,it is proper to build water bar.

The borrow pit is generally allowed to be built on the side slopes of embankment, the distance between the borrow pit and the natural protective channel between the embankment feet shouldn't be less than 10m.

5. Road bed engineering

(1) The soil for roadbed building must be in accordance with the rule and the soil which contains grass skin, non—frozen soil which has a high water content, grass skin, non—frozen soil which has a high water content, frozen soil can not be used as filler, snow and ice mustn't be mixed with soil and stone used as filler.

(2) when using frozen soil to fill the embankment, we should fill come frozen soil around the frozen lumps , which are supposed to be no larger than 15cm, and the volume of frozen soil should not be filled within 1m under the surface, it is better to use non---frozen soil or the soil with excellent water permeability.

(3) The embankment building should be filled by layers and tamping in pieces, the thickness of tamping layers, should be reduced by 20—25%less than the standard in warm seasons, the times for repeating tamping is supposed to be increased. The density of tamping should no less than that of general embankment references:

1. ziwang wu ect The Frozen Roadbed Engineering , published by lan zhou university ,1988
2. Yuan lin zhu ect The calculation for melting compressing and subsiding of Frozen Roadbed , Collection of Essays on the Research on Frozen Soil in Qinghai—xi zang published by science press, 1983