CONSIDERATIONS IN CASTING CONSTRUCTIONAL ELEMENTS OF REINFORCED CONCRETE BRIDGES AND AFFORDING PROTECTION AGAINST HEAVY FROST.

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Construction of reinforced concrete bridges in Mongolia had been conducted from 1940 to 1990s by the USSR /former name/ technical assistance, as well as by road builders from the People's Republic of China from the late 1950s to early 1960s, and from 1960s to the present the job has been carried out by Mongolian national bridge construction organizations. Basically more than 60 years have passed since the beginning of construction of reinforced concrete bridges in Mongolia.

In recent years much significance has been given to the intensification of investigations on utilization of the built bridges and setting up the level of their technical use. It has a great importance for lengthening the life cycle of bridges currently in use, detect damages and deterioration processes, eradicate the negative factors which were established by the investigation in order to advance constructional design and technological function of new bridges to be constructed, as well as for creating a possibility to use advanced technology and optimal construction in the maintenance of existing bridges. There is little evidence of research, conclusions and recommendations on affording protection against risks and unexpected negative natural and weather impacts.

1. The effects of outside temperature on casting concrete.

In this paper we attempted to find out to what extent the natural and weather factors of Mongolia, in particular temperature factors, have an effect on building of constructional elements of bridges, as well as on their utilization, and to identify the issues needed consideration in future.

The investigation is conducted on utilization of 11 reinforced concrete bridges built on larger rivers of Mongolia and it was established by the investigation that there is a significant factor which effect quality of bridges.

There is an interesting fact that fluctuations of Mongolian extremely changeable weather have a great influence on casting concrete and prestressed concrete constructions on-site. Here we have to consider a notion of a *freeze-thaws period* in casting concrete, referring to temperature fluctuations. This period occurs twice a year and if we look at this in terms of months and days of its occurrence we can define *spring thaws* or period from the 10^{th} to the 20^{th} of April, and *autumn frosts* or period of time from the 10^{th} to the 20^{th} of October. This can be seen from the multi year average temperature indicators shown on the Graph attached to this paper. The indicators refer to entire territory of Mongolia. The highest and the lowest points of temperature fluctuations have been set up on the basis of hydro-meteorological research conducted in Ulaanbaatar area, and they occur on:

- the 15^{th} to the 20 of April – spring thaws , and
- the 5^{th} to the 10^{th} of October - autumn frosts.

Duration of the freeze-thaws period was determined on the basis of research materials of multi year hydro-meteorological observations. We have made an approximate estimation of freezing time of concrete parts used in the investigated bridges and found out that the constructional elements were cast during freeze-thaws periods, identifying it by the date when the bridges were put into use. It is because of concrete casting work, including joining cross beams of a bridge span with slabs, casting the safety barriers and other exposed to the weather constructional elements of roadways are done either before utilization of a bridge or at the last stage of technological sequence. The detailed descriptions are shown on Table 1 and the Graph.

It was also revealed by the investigation that the problem is connected directly with a lack of measurements to be taken in terms of organization of making estimations on weather forecast for 10-15 days after concrete casting, finding out at what temperature point at night the cast concrete is strengthened, and affording protection of the cast elements against heavy frost, and most importantly, a lack of appropriate technical and technological oversight.

Thus Contractors and bridge designing organizations should consider the clear statement of all related to the issue technical conditions in the technical documentation of bridges.

Considering the difficulty of covering up and protecting the cast constructions from cold on-site, It would be correct if casting concrete work recommended to be done at certain time after or prior to the freeze-thaws periods.

On the example of the investigated bridges we can conclude that an overall evaluation of technical level of utilization has decreased by 5%-10% due to poor protection of cast concrete constructions against heavy frost during the freeze-thaws period.

Evaluations of technical levels of utilization of roadways and spans of the bridges have been decreased: by 20% to 25% as for the roadways and by 5% to 15% for the spans.

According to the investigation, it is appropriate to set up the following time limits for casting concrete in order to avoid such risks:

- **after a spring thaws period or after the 20th of April, and**
- **before an autumn frosts period or before the 25th of September**

Using these time limits, we assume that starting from the autumn frosts period or from the 25th of September we can provide up to 70% of concrete strengthening and setting up the time for casting concrete, subtracting 7-9 days required for intensive maintenance, we can reduce the risks.

Damages caused by heavy frost occurred during casting concrete

[1]	Bridges investigated	**Frostbitten constructions (determined by the investigation)**				**Utilization commenced /month, day/**	**Relation of the date to freeze-thaws period**
		Damages in concrete pavement	**Damages in concrete safety barrier**	**Distresses in pavement at joints of faulting**	**Cross beam joints**		
1	Khovd, Myangad som, RC bridge over Khovd river					**6 September**	
2	Bayan-Ulgyi, RC bridge over Khovd river	✕		✕	✕	**24 April**	
3	Bulgan, Selenge, RC bridge over Gurt river					**11 October**	

4	Tuv aimag, Lyun, RC bridge over Tuul river	✕	✕	✕	✕	**14 December**	
5	Baganuur, RC bridge over Kherlen river	✕	✕	✕	✕	**November**	
6	Undurkhaan, RC bridge over Kherlen river					**30 September**	
7	Choibalsan, RC bridge over Kherlen river					**30 August**	
8	Ulaanbaatar, Ikh Tenger, RC bridge over Tuul river	✕	✕	✕	✕	**7 November**	
9	Darkhan, RC bridge over Kharaa river	✕	✕	✕	✕	**15 November**	
10	Zuunkharaa, RC bridge over Kharaa river	✕	✕	✕	✕	**10 November**	
11	Tuv aimag, Zaamar, RC					**1 September**	

	bridge over Tuul river						
	Percentage %						**55**

Note:

X denotes damages caused by heavy frost (as established by the investigation)