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Autor: Nasch, Ludovit

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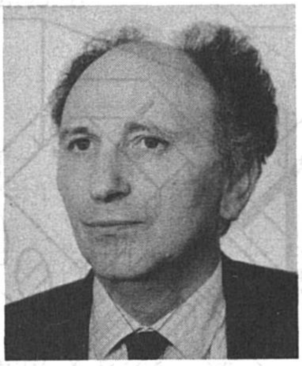
Interlayer Bond Deterioration under Repeated Shear Load

Ludovit NASCH
Principal R.W., Civil Eng.
USTARCH - SAV
Bratislava, Slovak Republic



Ludovit Nasch, born 1938, received his civil engineering degree in 1962 from the Slovak Technical University (SVST), and his CSc. in 1978 from the Slovak Academy of Sciences, where he works at the Institute of Construction and Architecture (USTARCH) in the department of mechanics.

Summary

Non-reinforced interlayer connections, as they are known from the concrete composite elements, has been investigated experimentally under both, monotone increasing and repeated loading. The purpose of our research was not only to obtain the limiting stress values (or the respective interlayer displacements) at the rupture, but also to investigate the energy dissipation during the whole process of interlayer bond deterioration. Due to the repeated loading *the quick data acquisition and storing technique* has been used.

1. Specimens, loading, experimental set-up, and instrumentation

In this part of the research project made at the Institute of Construction and Architecture of the Slovak Academy of Sciences, two families of specimen, (Figure 1), were experimentally analysed under both, monotone and repeated loading. The first of the families (where the overall breaking mechanism was aimed at) comprise the full size 1200 x (70+170) x 6000 mm, (breadth x thickness x length) specimens based on the precast, prestressed wide planks KAPPA, produced by the ZIPP Ltd. - Bratislava. The second family of which only we will speak further, consists of the smaller size 200 x 200 x 600 mm three layer specimens, where the importance of such parameters as the interface roughness, the normal stress intensity, the cube strength, and the workability of the concrete, changes of the concrete mix, etc., to the overall behaviour of the interlayer connection can be investigated more readily. The surface roughness *left-as-vibrated*, *roughened by the sheep-leg roller* (as used for the KAPPA planks), and *trawled by the wooden lath trowel*, and three levels of the normal stress intensity *(0,0; 0,1; and 0,4 MPa)* has been chosen for analysis. The Hydropuls - Schenck loading apparatus was used to load the specimen placed appropriately between the upper cross beam and the loading piston of the loading machine. Both loading types were displacement controlled; *the monotone increasing load* by the constant loading piston velocity of 1/100 mm per second, and *the repeated loading* by the sinusoidal motion of the loading piston. Up to 2,0 x 10^6 loading cycles with the 14 Hz frequency were imposed on the specimen. The piston's lower and upper position were so adjusted, to have the upper loading force at the required level, and the lower value of the loading force to be approx. 10 or 15 kN. Altogether nine IWT 302 inductive gauges were used to measure changes of the length base across the interlayer connection, (channels 1-4), the vertical interlayer slip, (channels 6-9), and the loading piston position, (channel 10). The loading force intensity was acquired from the channel 5.

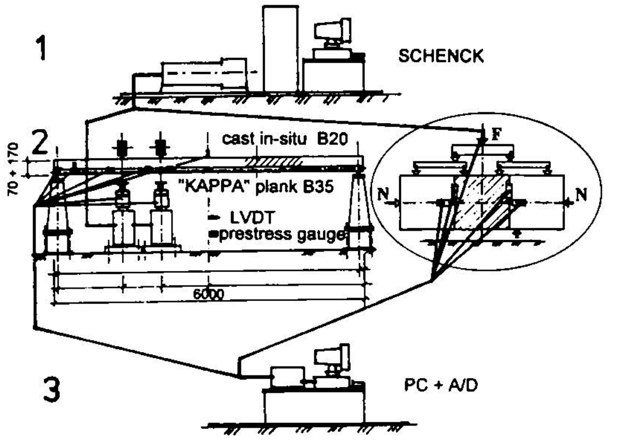


Figure 1

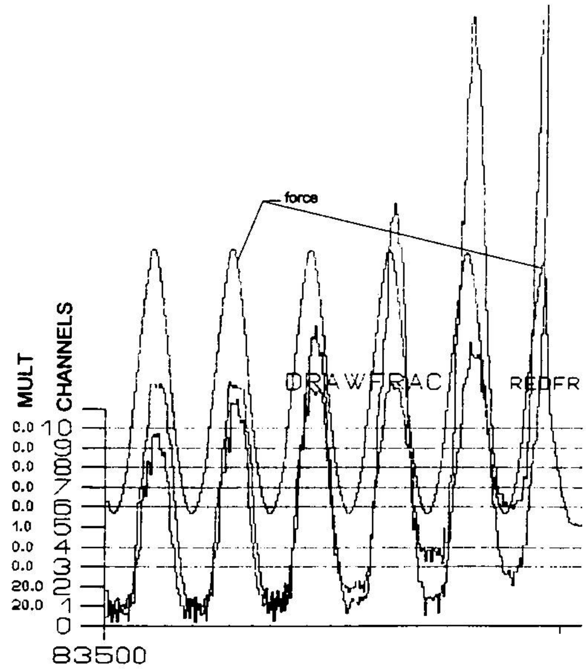


Figure 2

2. Results and discussion

On the Figure 2 we can see selected primary data as acquired during the last 6 cycles (from approx. 14000) before final rupture of the second interlayer connection of the 25/VI three layer specimen (surface roughness *left as vibrated*, and σ_n = 0,4 MPa). The whole experiment has been scanned with the sampling frequency of 600 Hz, and so the vertical line segments creating any of the depicted curves are, in this case, the 1/600 sec. apart. Length between the numbered ticks on the vertical axis equals 1/100 mm for the displacements, and 20kN for the loading force. We can see (alike the data for different normal stress, and interface roughness, and monotone load, published elsewhere, [1]) the significant increase of the measured displacements in the pre-critical part of the diagrammed data. There is an increase of displacements across the connection plane between 12 and 13 x10^{-2} mm for the last 100 cycles, (6 to 10 x10^{-2} mm for the last 10 cycles) without any significant loss of the connection's stiffness, as well as the energy accumulated during the loading phase. It should be reminded at this place, that the crack opening of about 1/100 mm is discernible by the naked eye. On the ground of the experimental evidence could be stated, that not the interlayer *adhesion* only, (accounted for in the fracture mechanics), but also the *mechanical interlock* due to the surface roughness, and the *friction* due to the normal stress intensity, together with the manufacturing conditions, play the main, if not the decisive role.

References

1. Nasch, L.: Behaviour of interlayer connections between the old and new concrete. In: Proceedings of the First Slovak Conference on Concrete Structures, STU, Bratislava, Sept. 1994, pp. 100 - 107.

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