REMEDIEREA FISURILOR DE TIP F₀ (Δ<0.5mm)
CRACKS RETRIEVAL TYPE F₀ (Δ<0.5mm)

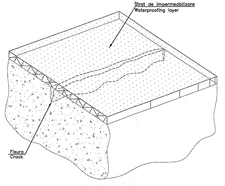

FIG. 1 APLICAREA STRATULUI DE IMPERMEABILIZARE
APPLYING THE WATERPROOFING LAYER

Tehnologia lucrarilor de reparatie a suprafetelor de beton cu fisuri de tip f ₀
(fisuri cu deschiderea mai mica de 0.5mm) conf. C149-97 (fig. 1):

1. Se identifica si se marcheaza fisurile de tip f_0;
2. Se curata de impuritati suprafata betonului in lungul fisurii cu perie de sarma si se indeparteaza praful cu jet de aer sub presiune;
3. Se aplica stratul de impermeabilizare si uniformizare a aspectului betonului (acest strat se va aplica la final pe intreaga suprafata de beton vizibila, dupa realizarea lucrarilor de reparatii).

Technology of repair works to the concrete areas with type f ₀ cracks
(cracks with widths lower then 0.5mm), acc. to C149-97(fig. 1):

1. Identifying and marking the cracks of type f_0;
2. Cleaning the impurity from the concrete area along the crack using the wire brush and clearing the dust with compressed air stream;
3. Applying the waterproofing / levelling layer of the concrete surface (this layer shall be placed finally on the entire visible concrete area after executing the repairs works).

CARACTERISTICI TEHNICE ALE MATERIALELOR UTILIZATE:

A. Strat de impermeabilizare conform caietului de sarcini ce se va aplica cu pensula sau cu pistolul de torcretat si avand urmatoarele caracteristici:

• Material de baza	ciment;
• Numar minim de straturi	2;
• Grosimea min. a stratului aplicat	2mm;
• Vascozitatea la 10°C	cca. 1000–1500 MPas;
• Vascozitatea la 20°C	cca. 500–700 MPas;
• Durata lucrabilitate la 20°C	>45min;
• Temperatura min. de aplicare	+10°C;

TECHNICAL SPECIFICATION OF THE USED MATERIALS:

A. Waterproofing layer according to technical specification which will be applied using paintbrush or shotcrete gun and shall have the following requirements:

• Base material	cement;
• Number of necessary layer	2;
• Minumum thickness of the layer	2mm;
• Viscosity at 10°C	cca. 1000–1500 MPas;
• Viscosity at 20°C	cca. 500–700 MPas;
• Time before hardening at 20°C	>45min;
• Minimal temperature for applying of support layer	+10°C;

REMEDIEREA FISURILOR DE TIP F₁(Δ=0.5÷2mm)
CRACKS RETRIEVAL TYPE F₁(Δ=0.5÷2mm)

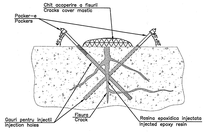

FIG. 2 SECTIUNE TRANSVERSALA PRIN FISURA
CROSS SECTION OF CRACK

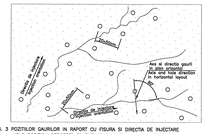

FIG. 3 POZITILOR GAURILOR IN RAPORT CU FISURA SI DIRECTIA DE INJECTARE
HOLES POSITION REPORTED TO THE CRACK AND INJECTION ORIENTATION

Tehnologia lucrarilor de reparatie a suprafetelor de beton cu fisuri de tip f ₁
(fisuri cu deschiderea 0.5÷2.0mm), conf. C149-97 (fig.2, fig.3):

1. Se identifica si se marcheaza fisurile de tip f_1;
2. Se curata de impuritati suprafata betonului in lungul fisurii cu perie de sarma si se indeparteaza praful cu jet de aer sub presiune;
3. Remedierea fisurilor se va face fie cu rasini epoxidice fie cu suspensie de ciment (sunt utilizate numai cimenturi cu finete mare de macinare) astfel:
   – Se stabilesc si se marcheaza pozitiile gaurilor (fig.3);
   – Se executa gaurirea cu diametrul pozitiilor de pe grosimea stratului sa fie perpendiculare pe fisura si cu inclinarea de 45°÷60° fata de suprafata exterioara a betonului (fig.2);
   – Se curata suprafata cu aer sub presiune si se monteaza packer-ele;
   – Se injecteaza fisura la exterior prin aplicarea de-a lungul acesteia a unui chit epoxidic (fig.3);
   – Se monteaza packer-ele de injectare (conf. fig. 2 si fig. 3) incepand cu unul din capete (in cazul fisurilor verticale sau inclinate de pe suprafetele de beton verticale, se va incepe de la capatul inferior). Pe durata executiei injectiilor se vor pastra deschise doar doua packer-ere invecinate, restul vor fi inchise. Cand prin packer-ul urmator, se va continua injectia de la acesta. Umplerea fisurilor se va face cu o presiune initiala de 2÷3 bar in cazul fisurilor umede si 3÷6 bar in cazul fisurilor uscate. Dupa cca. 60÷90 minute se vor relua operatiunile de injectare cu o presiune dubla fata de cea initiala;
   – Se inlatura packer-ele si stuful la 48 ore de la finalizarea lucrarilor de injectare;
   – Se finiseaza suprafata de beton din lungul fisurii (suprafata echivalenta cu cea acoperita de chit);
4. Se aplica stratul de impermeabilizare si uniformizare a aspectului betonului (acest strat se va aplica la final pe intreaga suprafata de beton vizibila, dupa realizarea lucrarilor de reparatii).

Technology of repair works of the concrete areas with type f1 cracks
(cracks with opening 0.5 ÷ 2.0mm), acc. C149-97 (fig.2, fig3):

1. Identifying and marking the type f1 cracks;
2. Cleaning the concrete surface from impurities with the wire brush along the crack and dust removing with compressed air stream;
3. Cracks remedying mode either with epoxy resin or cement suspensions(utilized only cements having great grinding fineness) as follows:
   – Identifying and marking the holes positions (fig.2);
   –Executing the holes such as their positions in horizontal plan to be perpendicular on the crack and in vertical plan to be at 45° – 60° as against exterior surface of the concrete (fig.2);
   –Cleaning of the holes with compressed air stream and mounting the packers;
   –Closing of the crack in exterior by placing epoxy putty along the crack (fig.2).
   – Executing the injection works (fig.2 and 3) starting from an end (for vertical or scalived cracks, the start shall be executed from the lower end). During the execution of the injections shall be kept opened only two packers, the rest of them shall be hermetically closed. When from the next packer the epoxy resin got out by the next packs, the injection will continue from that packer. The filling of the cracks is made with initial pressure of 2÷3 bar in case of wet cracks and 3÷6 bar in case of dry cracks. After ca. 60÷90 minutes the injection operations shall resume with a double pressure;
   – Removing the packers and the putty at 48 h, from the finishing of the injections works.
   –Finishing the concrete surface along the crack (the surface equivalent with the surface covered with putty).
4. Placing the waterproofing and levelling layer of the concrete surface (this layer shall be placed on finally on the entire visible concrete area, after executing the repair works).

CARACTERISTICI TEHNICE ALE MATERIALELOR UTILIZATE:

A. Suspensie de ciment conform caietului de sarcini si avand urmatoarele caracteristici:

• Granulatie ciment	<16µm;
• Finetea de macinare a cimentului	>15000cm²/g;
• Cantitatea de apa	50%;
• Rezistenta la compresiune	>50N/mm² la 28zile;
• Rezistenta la tractiune din incovoiere	>5.0N/mm² la 28zile;
• Rezistenta la tractiune	>2.0N/mm²;
• Umflare	<+0.1%
• Aplicabila pe suprafete umede;	

B. Rasina epoxidica conform caietului de sarcini si avand urmatoarele caracteristici:

• Vascozitate la 10°C	cca. 350MPas;
• Vascozitate la 20°C	cca. 400–500MPas;
• Durata de lucru la 10°	cca. 60÷75min;
• Durata de lucru la 20°	cca. 35–40min;
• Durata de lucru la 30°	cca. 20–30min;
• Timp de intarire completa	7 zile la 20°C;
• Rezistenta la tractiune	>1.0N/mm²

C. Strat de impermeabilizare conform caietului de sarcini ce se va aplica cu pensula sau cu pistolul de torcretat si avand urmatoarele caracteristici:

• Material de baza	ciment;
• Numar minim de straturi	2;
• Grosimea min. a stratului aplicat	2mm;
• Vascozitate la 10°C	cca. 1000–1500 MPas;
• Vascozitate la 20°C	cca. 500–700 MPas;
• Durata lucrabilitate la 20°C	>45min;
• Temperatura min. de aplicare pe stratul suport	+10°C;

TECHNICAL SPECIFICATION OF THE USED MATERIALS:

A. Cement slurry according to technical specification shall have the following requirements:

• Cement granulosity	<16µm;
• Degree of cement beating	>15000cm²/g;
• Quantity of water	50%;
• Compression resistance	>50N/mm² at 28 days;
• Stretching resistance from bending	>5.0N/mm² at 28 days;
• Stretching resistance	>2.0N/mm²;
• Expansion	<+0.1%
• Applicable on wet surfaces;	

B. Epoxy resin according to technical specification shall have the following requirements:

• Viscosity at 10°C	cca. 350MPas;
• Viscosity at 20°C	cca. 400–500MPas;
• Time before hardening at 10°	cca. 60÷75min;
• Time before hardening at 20°	cca. 35–40min;
• Time before hardening at 30°	cca. 20–30min;
• Baking time of resin	7 days to 20°C;
• Stretching resistance	>1.0N/mm²

C. Waterproofing layer according to technical specification which will be applied using paintbrush or shotcrete gun and shall have the following requirements:

• Base material	cement;
• Number of necessary layer	2;
• Minumum thickness of the layer	2mm;
• Viscosity at 10°C	cca. 1000–1500 MPas;
• Viscosity at 20°C	cca. 500–700 MPas;
• Time before hardening at 20°C	>45min;
• Minimal temperature for applying of support layer	+10°C;

REMEDIEREA FISURILOR DE TIP F₂ (Δ>2mm)
CRACKS RETRIEVAL TYPE F₂ (Δ>2mm)

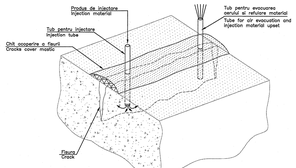

FIG. 4 REPARAREA FISURILOR PRIN UTILIZAREA TUBURILOR
CRACKS REPAIRING BY USING TUBES METHOD

Tehnologia lucrarilor de reparatie a suprafetelor de beton cu fisuri de tip f ₂
(fisuri cu deschideri > 2mm) conf. C149-97 (fig.4, fig.5 si fig.6):

1. Se identifica si se marcheaza fisurile de tip f_2;
2. Se curata de impuritati suprafata betonului in lungul fisurii cu perie de sarma si se indeparteaza praful cu jet de aer sub presiune;
3. Remedierea fisurilor se va face fie cu suspensie de ciment (sunt utilizate numai cimenturi cu finete mare de macinare) astfel:
   – Se stabilesc si se marcheaza pozitiile tuburilor fie a ajutorilor metalice (fig.6) pe lungul fisurii, in cazul utilizarii tuburilor se vor da gauri ale caror diametre se vor stabili functie de tipul echipamentului pentru injectarea fisurii;
   – Se fixeaza tuburile sau ajutarele cu chit;
   – Se injecteaza fisura la exterior prin aplicarea de-a lungul acesteia a unui chit epoxidic (fig.4). Chiturirea se va face incepand cu unul din capete (in cazul fisurilor verticale sau inclinate de pe suprafetele de beton verticale, se va incepe de la capatul inferior). Pe durata executiei injectiilor se vor pastra deschise doar doua tuburi sau ajutare invecinate, restul vor fi inchise. Cand prin tubul sau ajutarul urmator, se va continua injectia de la acesta. Umplerea fisurilor se va face cu o presiune initiala de 2÷3 bar in cazul fisurilor umede si 3÷6 bar in cazul fisurilor uscate. Dupa cca. 60÷90 minute se vor relua operatiunile de injectare cu o presiune dubla fata de cea initiala;
   – Se inlatura chitul si tuburile sau ajutarele la 48 ore de la finalizarea lucrarilor de injectare, urmand a se efectua o verificare a lucrarilor de injectare de-a lungul intregii fisuri;
   – Se finiseaza suprafata de beton din lungul fisurii (suprafata echivalenta cu cea acoperita de chit);
4. Se aplica stratul de impermeabilizare si uniformizare a aspectului betonului (acest strat se va aplica la final pe intreaga suprafata de beton vizibila, dupa realizarea lucrarilor de reparatii).

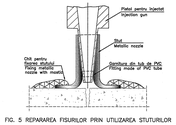

FIG. 5 REPARAREA FISURILOR PRIN UTILIZAREA STUTURILOR
CRACKS REPAIRING BY USING METALLIC NOZZLES METHOD

Technology of repair works of the concrete areas with f2 cracks (cracks with openings > 2mm) acc. to C149-97 (fig.4, fig.5 and fig.6):

1. Identifying and marking the type f2 cracks.
2. Cleaning the concrete surface by the impurities with the wire brush along the crack and dust removing with pressured jet.
3. Cracks remedying with cement suspension (utilised only cements having great grinding fineness) as follows:
   – Identifying and marking the holes shall be applied either the tubes or the nozzles (fig.6) along the crack.In case of the tubes utilisation the holes diameter shall be chosen depending on the type of the equipment used to remedy the cracks.
   – Fixing the tubes and the nozzles with putty.
   – Injecting the crack in exterior by placing epoxy putty (fig.4). The operation must include the areas round the tubes and nozzles.
   – Checking the communication between tubes and nozzles, after the putty indication by introducing compressed air. When between two adjacent holes the air does not exhaust, supplementary tubes or nozzles will be mounted because in this area the crack line is interrupted.
   – Executing the injection works starting from an end (in case of vertical or oscilived cracks the start shall be executed from the lower end). During the injections execution only two adjacent holes shall be kept opened, the rest of them shall be hermetically closed. The filling of the cracks shall be executed with an initial pressure of 2÷3 bar for the wet cracks and with a pressure of 3÷6 bar for dry cracks. After 60÷90 minutes the injections works shall be resumed at a double pressure.
   – Removing the tubes or the nozzles at 48h from the finishing of the injections works and checking of the works along the whole crack.
   – Finishing the concrete surface along the crack (the surface equivalent with the surface covered with putty).
4. Placing the waterproofing and levelling layer of the concrete surface (the waterproofing layer shall be placed on when the entire repaired area is dried).

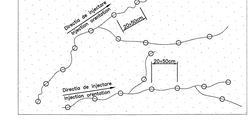

FIG. 6 MARCAREA POZITILOR TUBURILOR SAU STUTURILOR SI DIRECTIA DE INJECTARE
MARKING THE POSITIONS OF TUBES OR METALLIC NOZZLES AND INJECTION ORIENTATION

1. Conform H.G. 766/1997 lucrarea se incadreaza in categoria "B" a constructiilor de importanta deosebita.
2. Proiectul va fi verificat de verificatori atestati MLPAT la exigentele A.4, B.2 si D.2.

1. Complying with H.G. 766/1997 this structure belongs to category "B" of importance.
2. The project will be verified at A.4, B.2 and D.2 requirements.

NOTA:
1. La executia ce vor respecta cu strictete prevederile din "Codul de practica pentru executarea lucrarilor din beton, beton armat si beton precomprimat", indicativ NE 012-1/2007, din "Instructiunile tehnice privind procedeele de remediere a defectelor pentru elementele de beton si beton armat" indicativ C149-97, din "Normativul pentru verificarea calitatii si receptia lucrarilor de constructii aferente" indicativ CS6–85, si a Caietului de Sarcini.
2. Daca in timpul lucrarilor se vor constata anumite neconcordante intre datele avute in vedere la proiectare si situatia de pe teren, va fi convocat proiectantul pentru adaptarea proiectului la noua situatie.

NOTE:
1. There will be strictly respected the provisions from "Practice code for plain concrete, reinforced concrete and prestressed concrete works execution" ind. NE012-1/2007, "Technical instructions regarding remedial procedures of plain concrete and reinforced concrete" ind. C149–87, from "Normative for quality checking and works reception for different constructions" ind. CS6–85 and Technical Specifications of this project.
2. If during the execution works the designed data and the site situation are found out during works execution, the designer will be convened to adjust the design according to the new situation.

B					
A					
Rev.	Date	Modificare / Modification / Revision			
BENEFICIARY:		AUTORITATEA DE IMPLEMENTARE / IMPLEMENTING AUTHORITY	AUTORITATEA CONTRACTANTĂ / CONTRACTING AUTHORITY		Contract / Contract 3003289
ROMANIAN RAILWAY NATIONAL COMPANY		Ministerul Transporturilor / Ministry of Transports	Ministerul Economiei si Finantelor Oficiul de Plati si Contractare Pirate / Ministry of Economy and Finance Piraeus Payments & Contracting Office		
			UNIUNEA EUROPEANĂ / EUROPEAN UNION	POS Transport 2007- 2013	Faza / Phase PTh+DE
Intocmit / Designed	Ing. Adrian HADUCU		Proiect / Scale: 1:1	PROIECTUL ESTE PROIECT PRIORITAR COD 2001 PRIORITIZED PROJECT	
Verificat / Checked	Ing. Bogdan SANDU		Data / Date: 09 2009	Asistenta tehnica pentru pregatirea unor lucrari de reabilitare pentru tuneluri si podurile de cale ferata	
Sef proiect / Team leader	Ing. Stelian Vera-Cruz			Technical assistance for preparation of rehabilitation works required by tunnels and railway bridges	
				Denumirea desen / Drawing Title: Reparatii fisuri / Railway arena BUCIMEDI Linia 41 Rahova Vrs KM 0 + Poiana Tei	Cod desen / Drawing Code:
				Pod / Bridge Km 47+540 DETALII REPARATII SUPRAFETE DE BETON / DETAILS OF CRACKED CONCRETE SURFACES REPAIRING	PD 08
					Nr. / No. 06