

REVIVED METHOD OF RAPID REPAIR FOR RIGID CONCRETE PAVEMENT CONSTRUCTIONS OF MILITARY AIRFIELD OPERATION SURFACES

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Terms and definitions

An **military airbase** is an aerodrome used by a military forces for the operation of military aircrafts



MILITARY AERODROME

A military aerodrome is a complex of specially prepared terrain sections, structural systems and equipment that ensure the take off, landing, accommodation and maintenance of military aircraft and helicopters, and the basing of air wings and squadrons.




MILITARY AERODROME DREWITZ



AIRFIELD



An **airfield** is a place at an aerodrome where aircrafts can take off, land and taxi



CHALLENGE



Repair of military runways, traffic areas or highly frequented civilian roads have one common challenge: They have to be completed within the shortest time span, and if possible during running traffic!

HISTORY



Up until the early 1980's, during runway surface repairs in the Air Force, aircraft at bases where repairs were taking place had to be temporarily relocated.

Relocation of aircrafts could take up to several months with high technical, logistic, operational and financial expenditure.

GENERAL DESCRIPTION



The developed technology enable the Air Force to repair damaged parts of the Airfield Operational Surfaces, in sections at night during the course of a few days.

The damaged surface needs to be removed by modern diamond cutting devices or by water jet technology.

A special pre-stressed concrete slab is then filled into the damaged area.

MILITARY ASPECTS




Moreover, this procedure was suited not only to repairs due to wear and tear damage, but also for the rapid repair of airfield operational surfaces damaged by weapons of war.

The restorative measures mitigate the ability of foreign threats to destabilize whole airfield bases.

MILITARY ASPECTS



An important part of the military's duties is post attack damage control including the following:


- Post Attack Reconnaissance,
 - Airfield Damage Repair - ADR focusing on the Repair of Airfields Operating Surfaces - RAOS and
 - Construction repair for stationary physical structures on military airfields.
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MILITARY ASPECTS



The key question with rapid airfield repair is the fastest possible restoration of the runway for operation of fighter aircrafts and transport planes when the runway is damaged by craters caused by bomb blast through outside influence.

Craters caused by explosions, which can be several meters in diameter, can be closed in less than three hours, where the runway will be similar to state to its original state.




PRE-STRESSED CONCRETE AIRFIELD SLABS - PAG

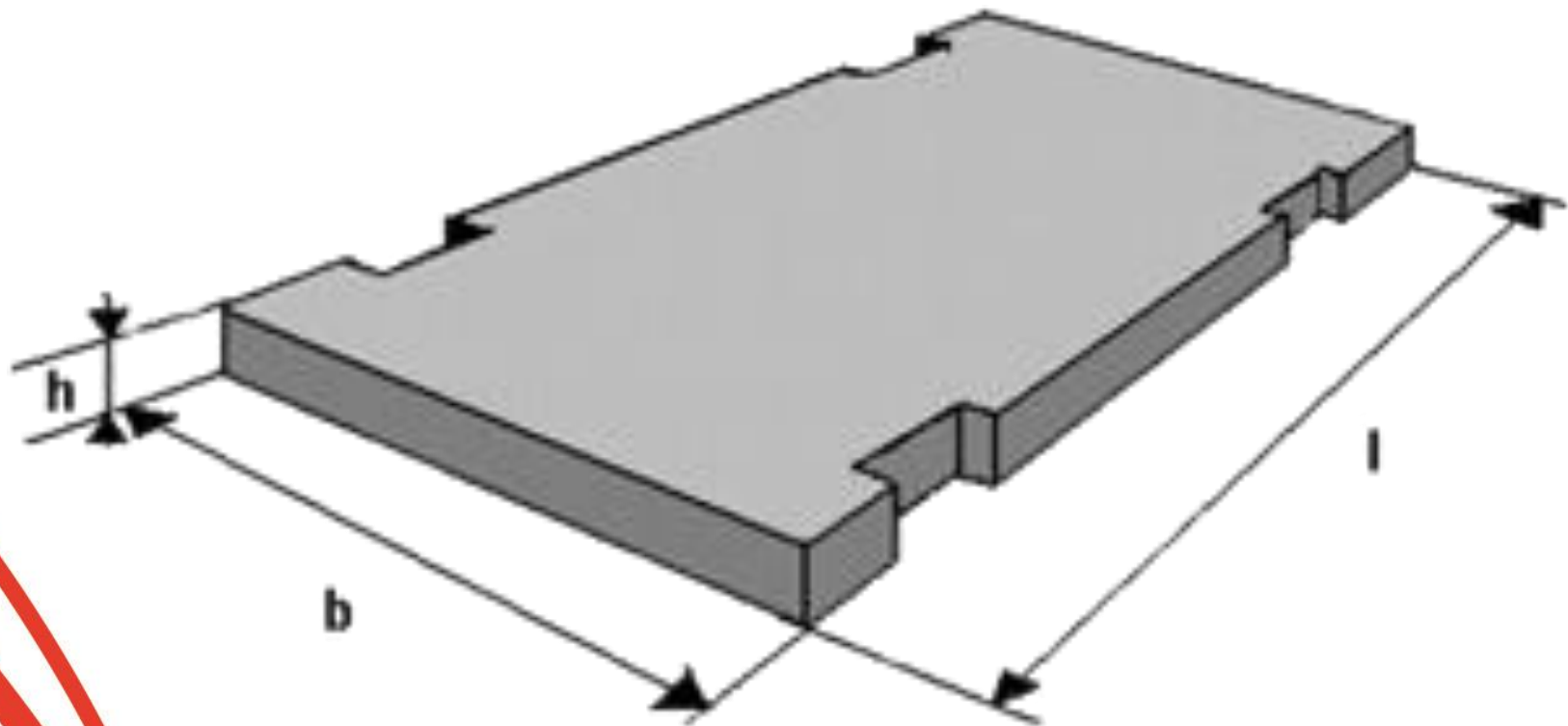


PAG in Russian stands for – Plita Aerodromnaya Gladkaya (translated into English - Smooth Airfield Slab).

Pre-stressed concrete airfield slabs of the type PAG are made of normal-weight concrete and are created with the special purpose for use as repair surfacing for Airfield Operating Surfaces.



PRE-STRESSED CONCRETE AIRFIELD SLABS - PAG




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Slabs PAG are produced in various thicknesses, PAG 14, PAG 18, PAG 20, PAG 24.

Each of these slabs are intended for differing service conditions.

Standard sizes of 6m x 2m with thicknesses of 140, 180, 200 and 240 mm are available.



PRE-STRESSED CONCRETE AIRFIELD SLABS - PAG




PRE-STRESSED CONCRETE AIRFIELD SLABS - PAG



Owing to the fact that the PAG slabs are used in the repair of airfield operating surfaces, the slabs are designed to be much stronger than normal pre-stressed slabs.

The strength and durability of the PAG slabs is increased by increased reinforcement accompanied by high strength concrete mixes.



PRE-STRESSED CONCRETE AIRFIELD SLABS - PAG



PRE-STRESSED CONCRETE AIRFIELD SLABS - PAG

The strength of PAG slabs is provided for by the use of pre-stressed reinforcement in the longitudinal direction, however no pre-stressing is provided for in the transverse direction.

The pre-stress reduces the size of cracks in the concrete in addition to reducing the area of steel and weight of concrete required.

Frost resistance of concrete - F 300.

PRE-STRESSED CONCRETE AIRFIELD SLABS - PAG


The maximum instant load that the slabs can maintain under severe weather conditions (temperatures of up to minus 60 degrees Celsius) without transgressing the frost action requirement is 75 tons per square meter.

PRE-STRESSED CONCRETE AIRFIELD SLABS - PAG



The working surface of slabs on which airplane tires are likely to run over should be rough.

Surface roughness is ensured by brushing working surfaces with Capron brushes or by canvas while the concrete is in a green state, after compaction of concrete in the mould formwork.



PRE-STRESSED CONCRETE AIRFIELD SLABS - PAG

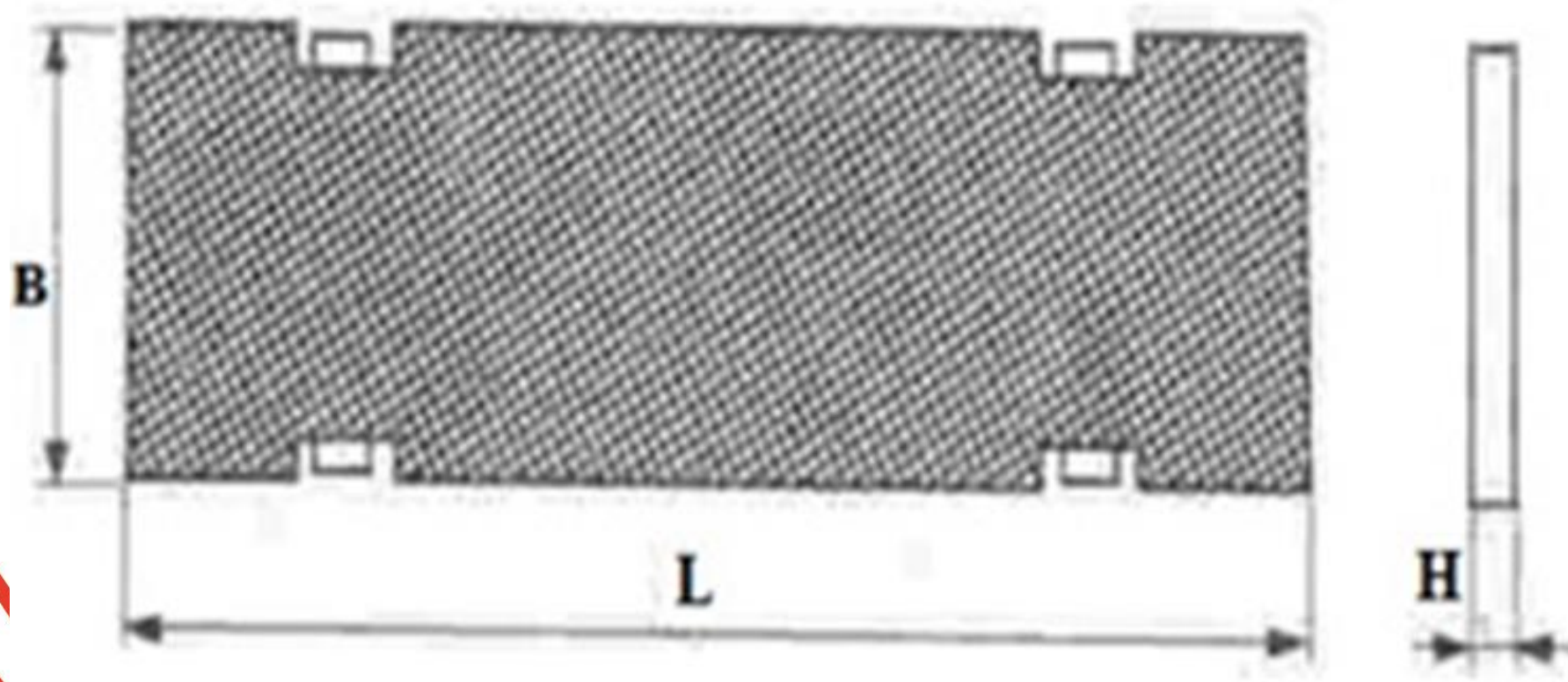
The underside of the PAG type slab should have corrugations.

The wearing surface of the slab is made of rhombus patterns increasing skid resistance for the surface.

Individual rhombus diagonals are perpendicular to the longitudinal axis of the slab.

Type corrugation depth used in practice is 1.2 mm.

PRE-STRESSED CONCRETE AIRFIELD SLABS - PAG



PRE-STRESSED CONCRETE AIRFIELD SLABS - PAG

Technical and economical indicators								
№	Designation	Volume, m ³	Weight, t	Concrete indicator		Tolerances (mm)	h (mm)	Apr. Price (EUR)
				Concrete class	Frost resistance			
1	2PAG 14Y-1B- CA	1,68	4,2	B25	F150	l= +/- 3 b= +/- 2 d= +/- 2	140	330
2	PAG14Y-1B-CA			B30	F300		140	380
3	PAG18Y-B-CA	2,16	5,4				180	450

1) GOST (Russian: ГОСТ) refers to a set of technical standards maintained by the Euro-Asian Council for Standardization, Metrology and Certification (EASC), a regional standards organization operating under the auspices of the Commonwealth of Independent States (CIS).

All sorts of regulated standards are included, with examples ranging from charting rules for design documentation to recipes and nutritional facts of Soviet-era brand names

(which have now become generic, but may only be sold under the label if the technical standard is followed, or re-named if they are reformulated).

GOST standards were originally developed by the government of the Soviet Union as part of its national standardization strategy. The word GOST (Russian: ГОСТ) is an acronym for gosudarstvennyy standard (Russian: государственный стандарт), which means state standard.


CONCRETE CUTTING PROCEDURES



Concrete diamond cutter

Diamond cutting tools in the modern construction industry provide for efficient, environmentally sound and precise work.

Advantage of diamond cutting technologies in comparison to traditional demolition procedures, include the following:

- Time savings,
 - Precision and dimensional exactness,
 - Environmentally benign technologies
 - Reduced dust and noise pollution
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Concrete diamond cutter



CONCRETE CUTTING PROCEDURES



Joint cutting

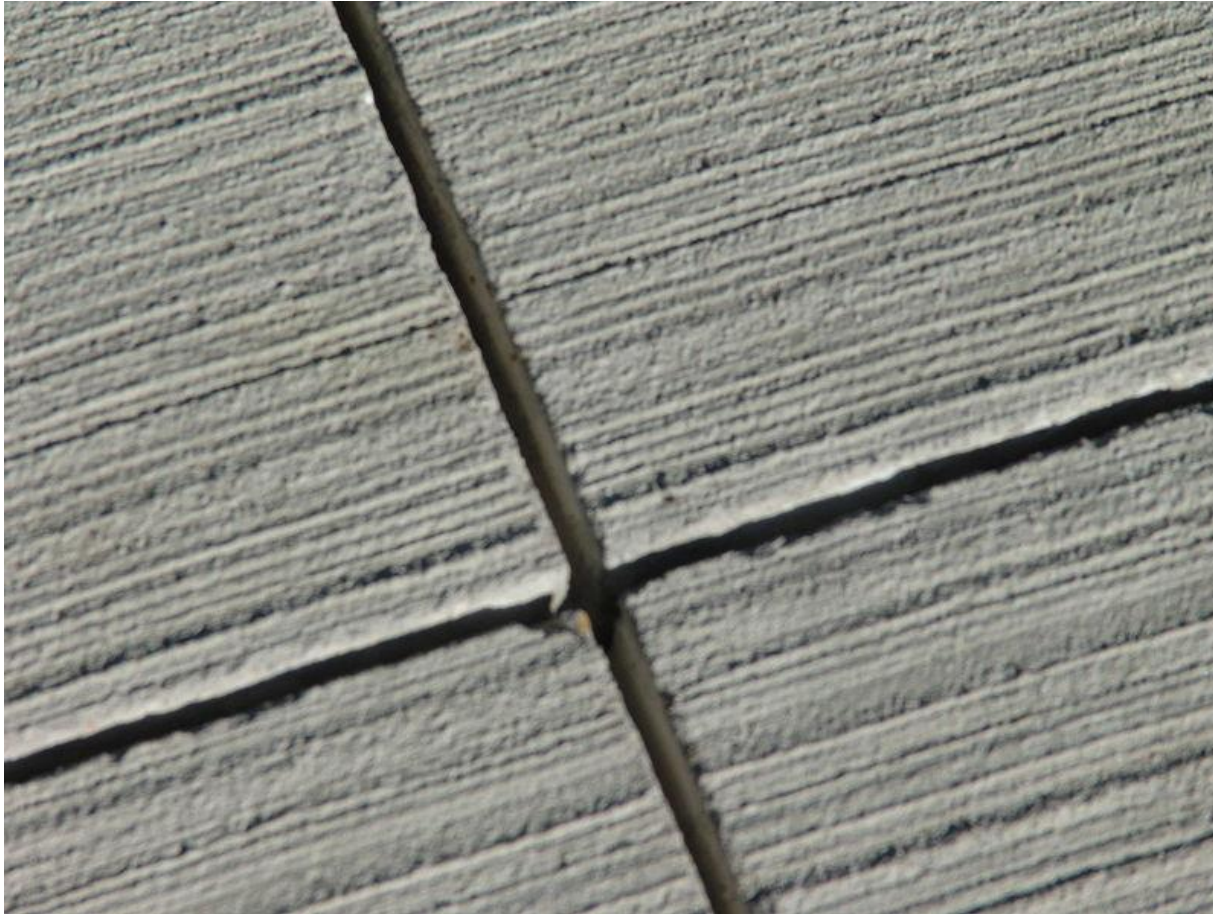
Joints are provided for in the runway by means of diamond cutters.

The diamond cutting technology is either electrically driven or diesel operated.

Standard cut depth: 50 cm.



Joint cutting



CONCRETE CUTTING PROCEDURES



The diamond cutting technology is preferred when dimensional-exact openings in the concrete are required, for example when an exact opening for a slab including joint size is required.


CONCRETE CUTTING PROCEDURES



High-pressure-jets of water

High-pressure-jet water technology is an innovative trendsetting technology.

This technology entails a highly energetic jet of water is used to remove damaged concrete or to the creation of new binding points under preservation of the existing reinforcement.

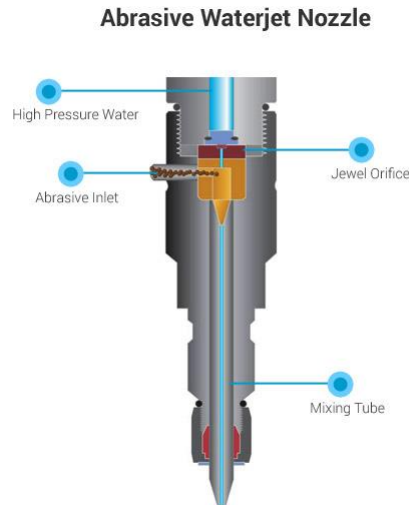


High-pressure-jets



Water jet cutting with maximum pressure water jet technology up to 6000 bar stationarily and 3000 bar mobilely.

The maximum pressure water jet technology is suitable for cutting almost all materials incl. concrete.



CONCRETE CUTTING PROCEDURES



The advantages compared with milling and diamond cutting are the following:

- 4% of the workforce required;
- The existing reinforcement is preserved;
- No damage due to vibration;
- No dust pollution;
- Minimal noise pollution.

CONCRETE RAPID REPAIR TECHNOLOGY



1. The damaged places are marked precisely, corresponding dimension of PAG slabs (2 m x 6 m) plus joint width.

Slabs can be laid in parallel or in series for greater damage dimensions.

CONCRETE RAPID REPAIR TECHNOLOGY



2. The marked concrete surface removed either by diamond cutter or by water jet technology up to the foundation level.

CONCRETE RAPID REPAIR TECHNOLOGY

3. In order to protect the slab against silt, a geotextile layer (150-200 g / m²) is introduced over the compacted soil. The voids between the geotextile and the corrugated underside of the slab are filled with a special dry concrete mixture. The concrete mix has a high fine grit portion and an accelerator is used to speed up the curing process.

CONCRETE RAPID REPAIR TECHNOLOGY



4. On the prepared fresh concrete surface, the PAG slabs are laid out immediate with joint distance, and if more than one slab is laid in parallel, the slabs are welded together by means of adjacent slab handling irons.

CONCRETE RAPID REPAIR TECHNOLOGY



5. Thereafter the whole slab surface is compacted with an elastic roller compactor to a final level of the adjoining concrete surface.

CONCRETE RAPID REPAIR TECHNOLOGY




6. The joints between concrete surfaces and PAG slabs are filled after suitable flank pretreatment with special quick-drying or coldhardening joint sealants. If curing time is not critical, hot joint sealants can be used. Cold joint sealants are considered more costly than hot joint sealants.

CONCRETE RAPID REPAIR TECHNOLOGY



7. Thereafter the airfield operation surface is usable again.



FIRST PRACTICE TEST



The first practice test of the new technology took place on the military airfield Drewitz, Germany in 1990.

Five damaged areas on the concrete runway (2500 m x 80 m) were completely repaired by a civilian construction company with support of military staff within 14 days.

FIRST PRACTICE TEST



FIRST PRACTICE TEST



FIRST PRACTICE TEST

Two flight groups, one fighter wing & one fighter bomber wing (JG 7 and JBG 37) remained in this time in the airfield location and carried out ground training.




FIRST PRACTICE TEST



CONCLUSION



Today this technology is revived and can widely applied in peacetime, during military conflicts and in wartime and is an very actual field of technical research (special concrete mixtures, cutting technologies, joint filling materials & technologies).



REFERENCES

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2. Adam, F.-M.; Final report on the initial testing of rapid repair of airfield operation surfaces with pre-stressed reinforced concrete elements in a short period without any relocation of air force units in portion of the airfield Drewitz. LSK/LV, 1990.
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Thank You