Structural and Technological Aspects of Folded Cores Application in Helicopter Panels

A.V.Shabalov
Kazan State Technical University named after A.N.Tupolev
420111, Karl Marx st., Kazan, Russian Federation
e-mail: pla@pla.kstu-kai.ru tel: (843) 236-64-94

Key words: rotorcraft, folded core, z-crimp, sandwich panels.

Abstract. Nowadays in structures of some helicopters fuselages, such as Mi-38 and Ka-226, are widely used sandwich panels. In most cases the core is honeycombs. In spite of high in-service structural performance with such a core they have some drawbacks. In particular, they collect condensate water during in-service operation. Its removal is quite a challenge. Also in process of honeycombs production are applied glued joints, which reduce panel service life.
Alternative for honeycombs is folded core. Its geometrical structure composes a system of interconnected continuous channels. In operation if condensate ingresses into the panels with such a core, it would be sufficient to dry-air purge its cavities.
Depending on geometry of folded core it might substitute for both honeycombs and stringer structures.
Folded core panels have got a technology advantage over honeycombs, as folded structure is made of a single sheet without cuttings and tears as long as with no glued joints. It allows to simplify core manufacturing process. Lack of glued joints increase its service life as compared to conventional honeycombs.

Folded core may be applied widespread in helicopter structure (fig. 1), such as side panels (1), tail boom panels (2), sound absorbent panels of engine and gear cowlings (3), screen-exhaust devices (SEDs), blade butt (5), inner partitions and panels.

Fig.1 Potential zones for folded core applications in helicopter structure.

Let us consider some versions of folded core applications in helicopter structure.

1. Inner partitions and flat fuselage panels

For example, in pilots cockpit it might be floor and partition between cockpit and fuselage (fig. 2).

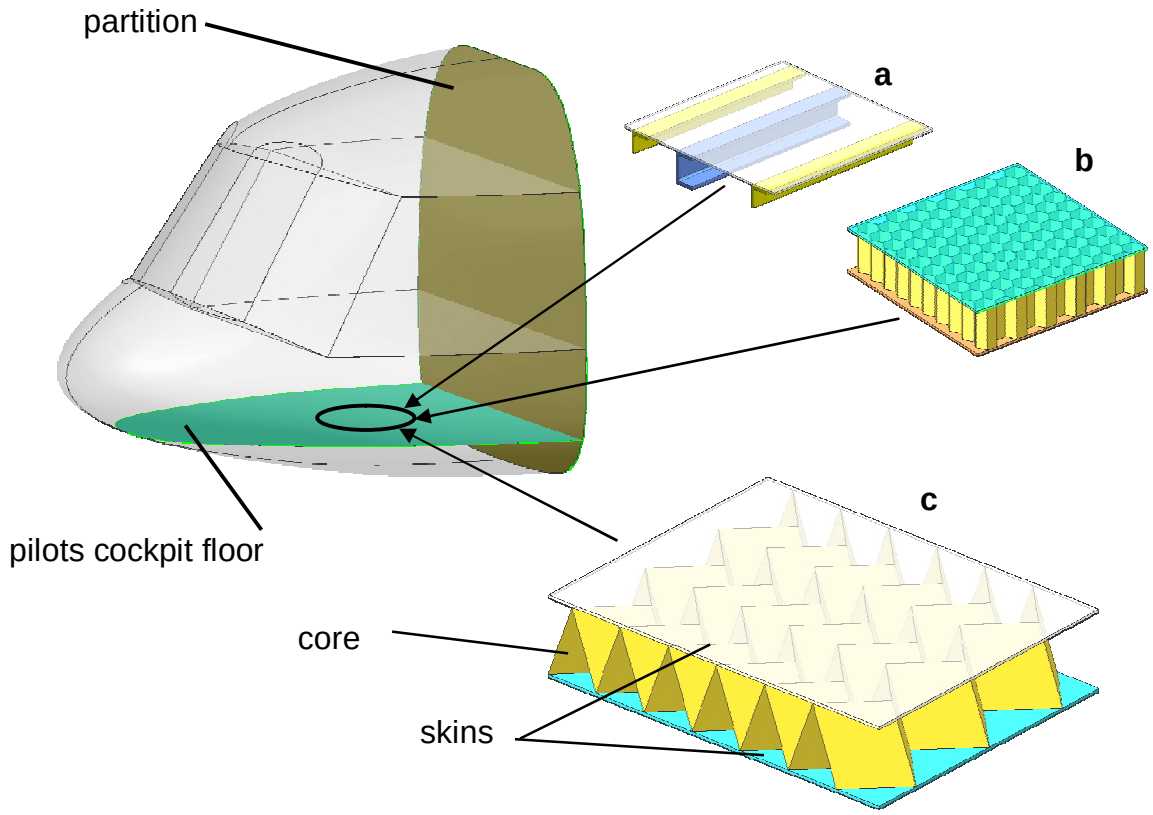

Fig.2 Design of inner panels and partitions: a,b – conventional panels with stringers and honeycombs; c – panel with z-crimp folded core.

By changing geometric parameters of folded core and material one may attribute to it both honeycomb and stringer panels properties.

Helicopter ceiling panel must possess good sound absorption. For these purposes today special sound absorbent materials are applied. Ceiling panel has stringer design. Z-crimp folded core application allows to integrate in a singe panel both load-bearing and sound absorbent functions (fig. 3).

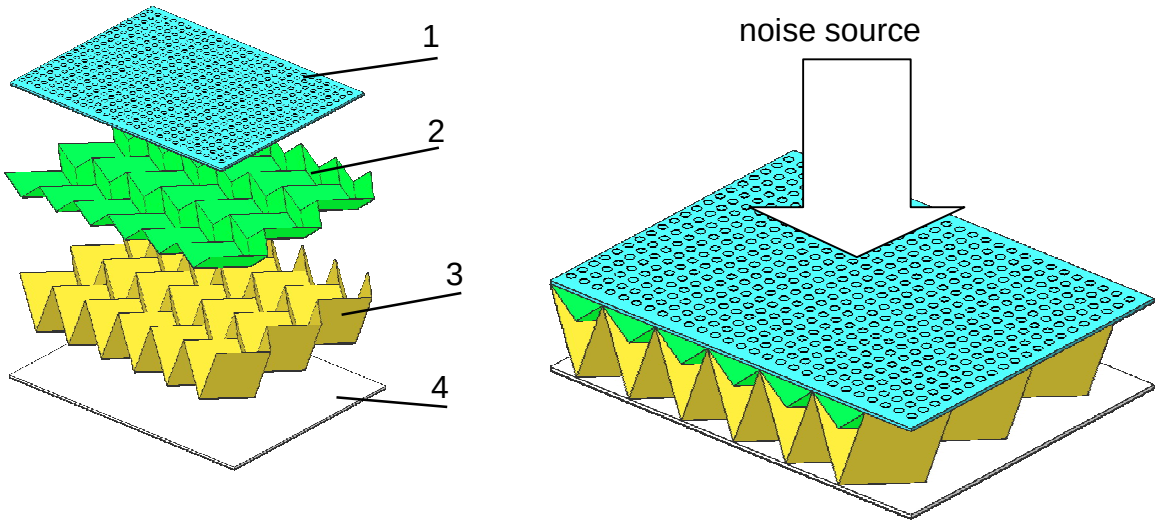

Fig.3 Design of helicopter ceiling sound absorbent panel: 1 – perforated skin; 2 – sound absorbent core; 3 – main core; 4 – skin.

Panel is posed with perforated skin towards a noise source (engines and gear).

2. Outer helicopter panels, tail boom.

Outer helicopter panels are curved, what makes it difficult to use honeycomb core, which in this case must be divided onto fragments with minor curvature. Z-crimp folded core applications allow to avoid it. A core can be made with specified size and curvature (fig. 4).

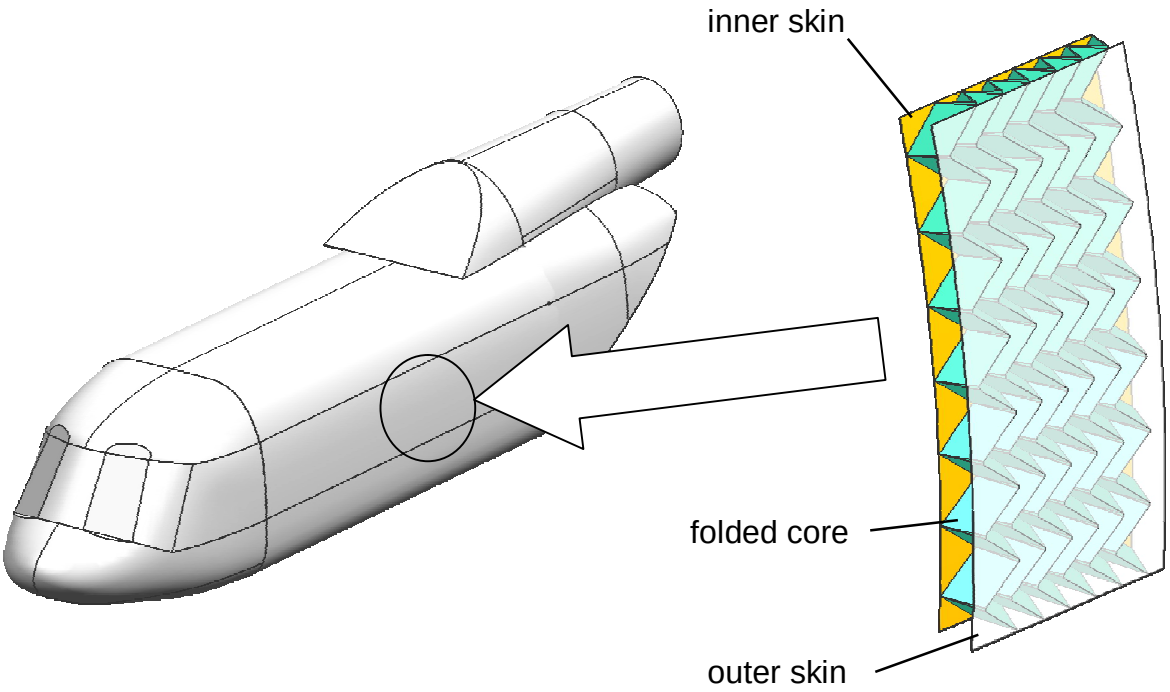

Fig.4 Design of helicopter side panel with folded core.

Folded core in helicopter tail boom seems to be very perspective application. Z-crimp folded core can be made in form of annular or spiral band. Panels and modules based on them then

are assembled on tail boom (fig. 5b). A helicopter tail boom also can be designed in form of one-piece construction. For this to realize one should apply z-crimp core in spiral form (fig. 5c)

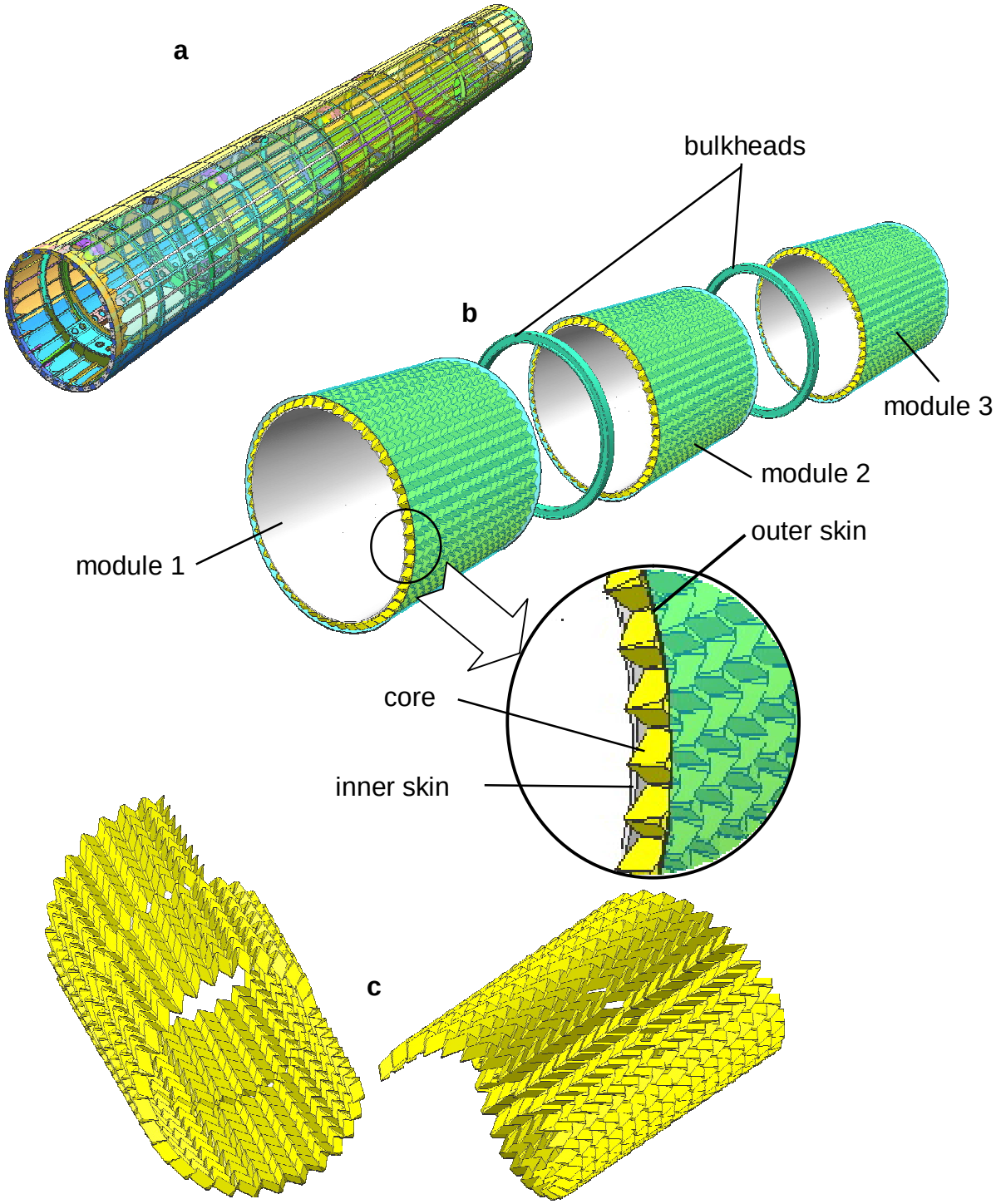

Fig.5 Different alternatives of z-crimp applications in helicopter tail boom design: a – conventional stringer design; b – design with modules with folded core; c – variant of one-piece z-crimp core in form of continuous band.

When cowling engine and gear compartments it is necessary to provide for good sound isolation. Cowling panels are curved, what makes it more difficult to use honeycomb core. That is why they are made basically in stringer design, which requires additional sound absorbent layer according to existing regulations.

Panels using z-crimp core allow to solve this problem. Such a panel simultaneously functions both as load-bearing and sound-absorbent structure.
To this effect one may use two panel designs (fig. 6 a, b):

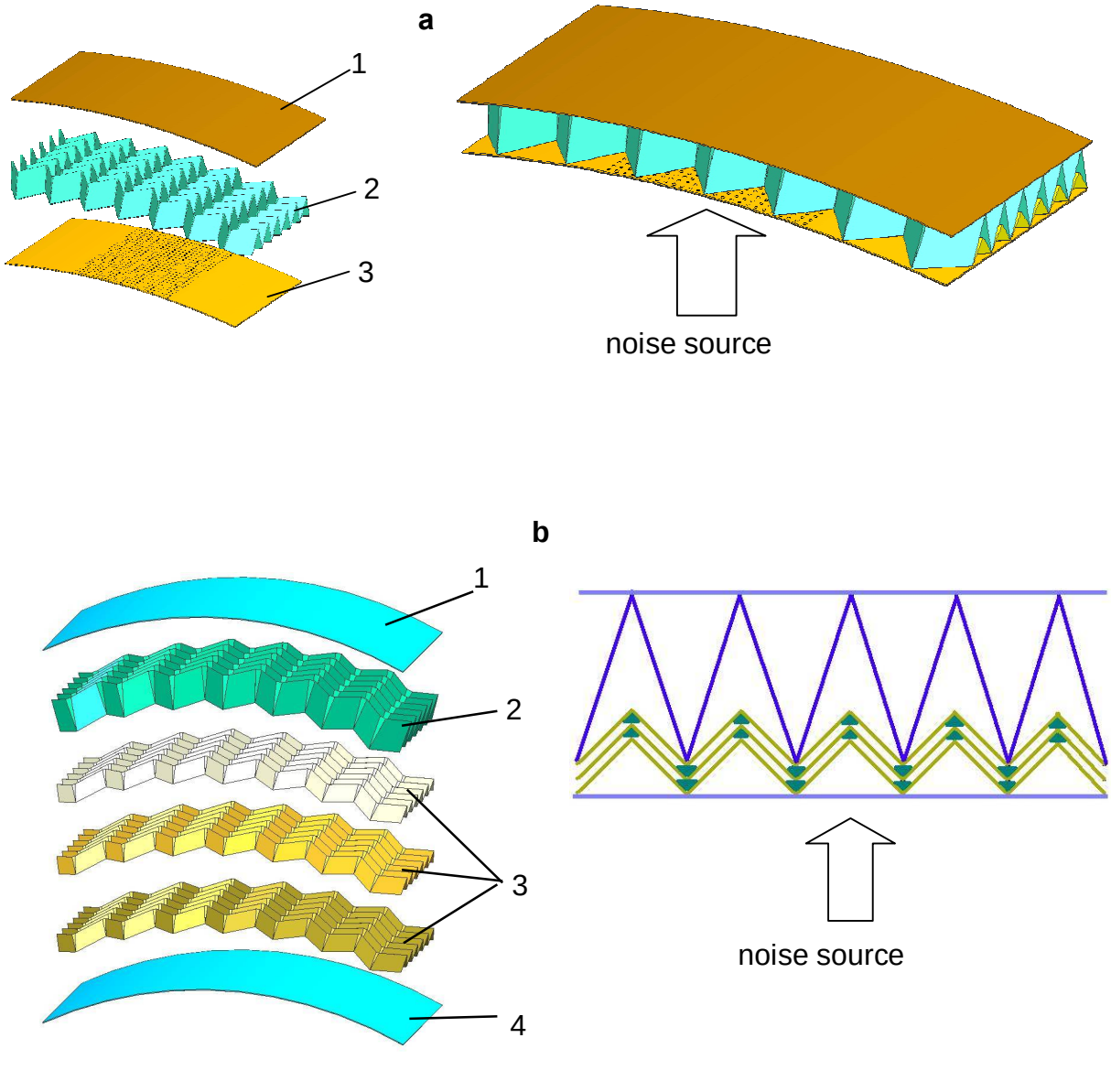

Fig.6 Sound absorbent panel of cowling:
a – with one-layer core (1 – outer skin, 2 – core, 3 – inner perforated skin)
b – with multilayer core (1 – outer skin, 2 – force core, 3 – sound absorbent core, 4 – inner perforated skin).

3. Helicopter stabilizer and main rotor blade.

Helicopter stabilizer has variable height along a profile chord. It designed both with stringer and honeycomb panels.
As an alternative may be proposed variable height folded core (fig. 7).

As against to conventional designs of stabilizer the design based on this core has the following advantages:

- easiness to remove condensate and humidity (as compared to honeycombs);
- its outer skins have smoother airstream surface (as compared to riveted stringer design);
- essentially decreased a number of details.

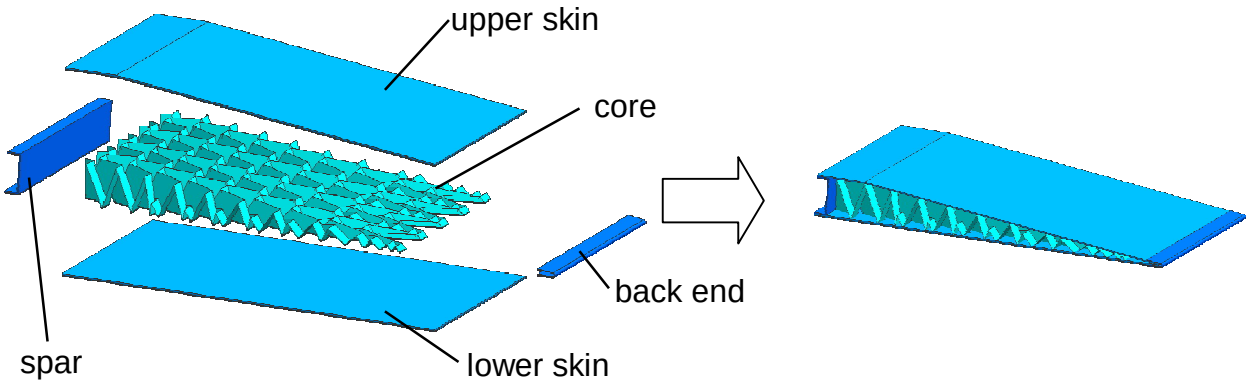

Fig.7 Tail end of a stabilizer is based on variable height folded core.

Main rotor blades are made in integral design: spar and tail end. Tail end consists of honeycombs. When water ingresses in honeycombs there might appear propeller unbalance.
Variable height folded core in tail end of a blade allows to eliminate these problems as it composes a set of continuous channels and is capable to self-purify. At propeller spinup a collected condensate and humidity would come outside of the channels under centrifugal force (fig. 8).

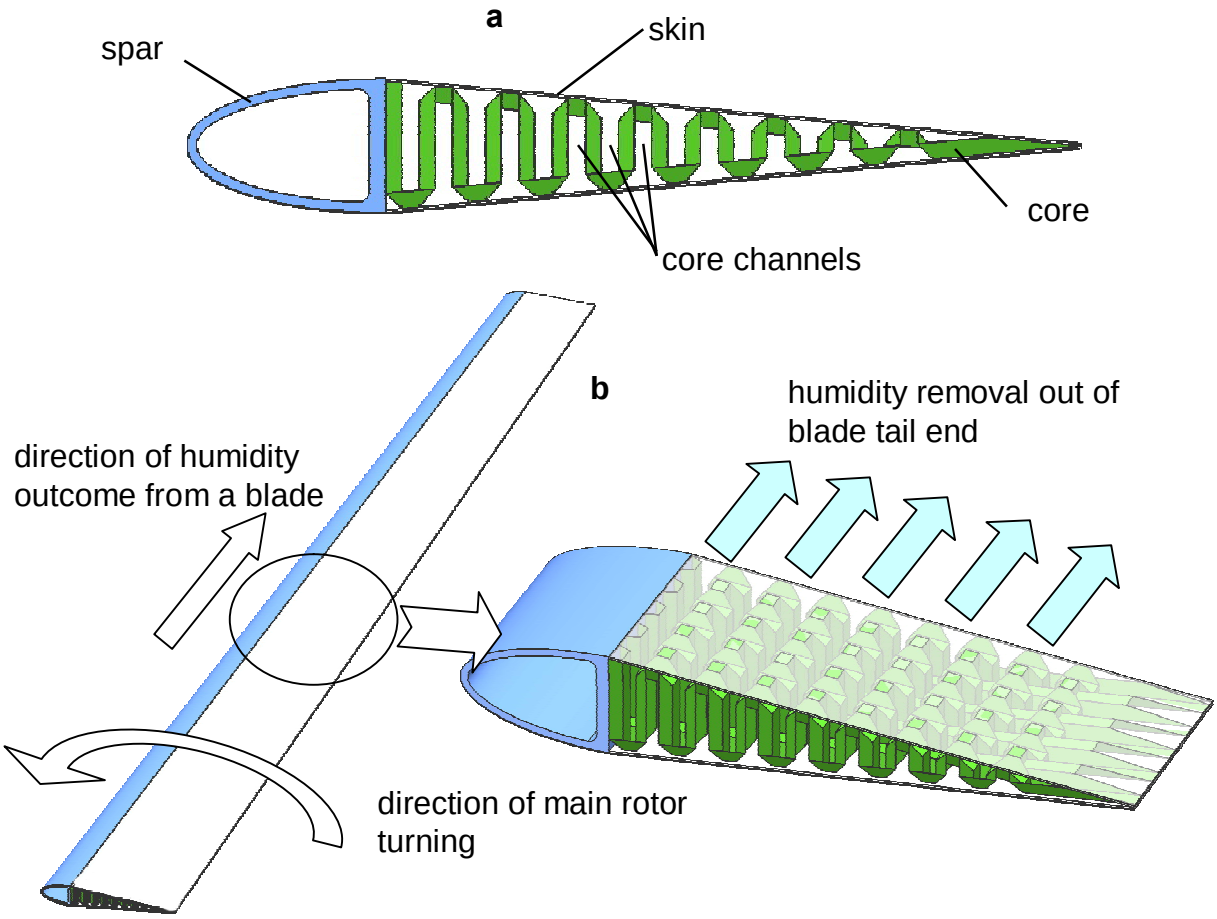

Fig.8 Tail end of a blade based on variable height folded core:
a – blade cross-section; b – blade self-purification at propeller spinup.

4. Screen-exhaust devices (SEDs)

Helicopter SEDs serve for decrease of exhausted gases and reduction of visibility in infrared wave band.

Folded core generates due to its geometry a set of continuous channels. Filtering through some channels exhausted gases and through another ones an ambient air allows to cool gases down to required temperature (fig. 9 a).

When hot gases from engine come to SEDs (fig. 9b) they distribute by means of selector (not illustrated in fig. 9) to specific channels of a cartridge. Cooled air from compressor comes to adjacent channels. While moving in the cartridge a heat exchange occurs. On SED exit the exhausted gases come out cooled down to required temperature.

Thanks to wide effective cooling surface SED overall size will significantly decrease. The cartridges can be inserted directly into engine compartment thereby reducing aerodynamic drag. When cartridge outages it is replaced by new one.

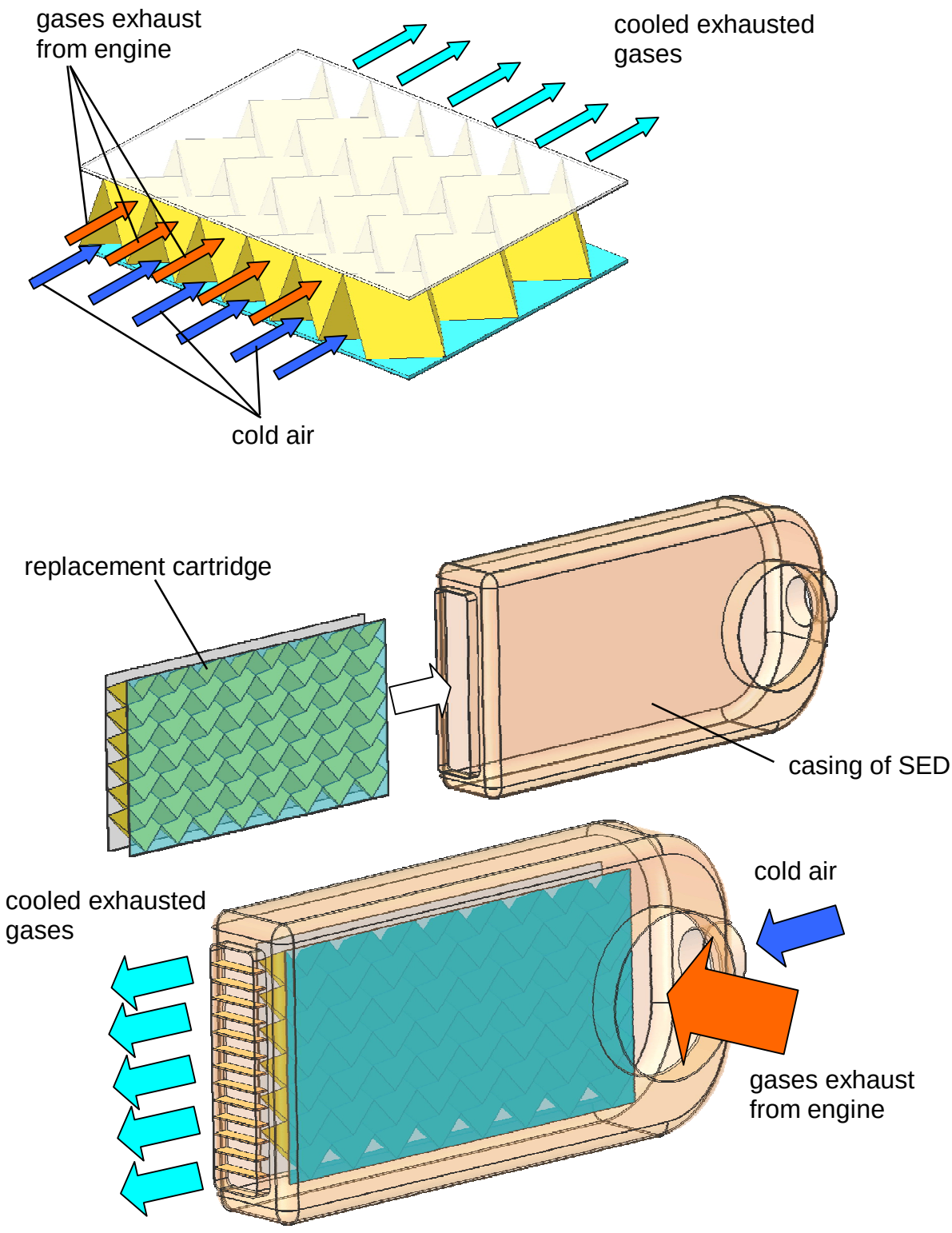

Fig.9 SED based on replacement cartridges with folded core:
a – SED operating principle; b – SED design