A flexible walled bag, tank (1), or flexitank, for shipping fluids, in particular liquids, disposed within an outer container (12) confines and supportable by a container floor, side walls and end structures, an upper tank surface being constrained, loaded or biassed, by external restraints, such as depending local spaced intrusions or baffles (22) extending from one side towards the other.
FLEXIBLE TANK FOR FLUID CONTAINERISATION

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of co-pending International Application No. PCT/GB2010/051856, filed on Nov. 8, 2010, which claims priority to PCT International Application No. PCT/GB2010/051809 filed on Oct. 28, 2010 and British Application No. GB0913497.8 filed on Nov. 9, 2009. The entire contents of each of the above-identified applications are hereby incorporated by reference.

FIELD OF THE INVENTION

[0002] This invention relates to the containerisation of bulk liquid storage and transport and is particularly, but not exclusively concerned with stabilising liquid contents under dynamic loads and thereby reducing stresses upon a container structure. The relative volumetric capacities of bag and container and/or the degree of bag inflation or fill and proportion of residual unoccupied interstitial or intervening space between bag outer and container inner impacts upon bag behaviour under liquid fill and in motion under accelerative and braking ‘g’ forces and even simply brisk lifting or lowering.

TERMINOLOGY

[0003] Where the context allows, for convenience on occasion alternative terms are used for corresponding parts, such as references to a bag surface or alternatively skin.

PRIOR ART

[0004] U.S. Pat. No. 6,186,713 Bobeck teaches a locally bound flexible bag, or rather a sub-divided bag, occupying significantly less than the entire internal volumetric capacity (so with a substantial unused void around the tank upper region) within container confines, for bulk goods shipment from powder to liquids. Perimeter space between bag and container walls is made available, so the under-utilisation of theoretical ultimate capacity is quite acute. The hazard of liquid surges under accelerative loading, including cornering, is recognised as a challenge, resolved by adjustable local pressure straps, as over-wraps or ties upon the bag to a container base or floor platform, rather than a bounding wall or frame structure, to unify the contents as a solid mass and prevent internal fluid movement. The local (circumferential) wrap pressure effect is as if there were internal baffles and compartmentalises the contents into cells. Reliance is place upon a sturdy container wall, along with an internal bag liner. A pressure monitor is used to avoid over- or under-pressureisation. Cross-contamination between different loads is a concern, so a dedicated single product or product category bag is envisaged. So this represents a rather an elaborate and expensive approach. A simpler flexible tank in container box is supplied by CST (Container- Speditions- and Transportges), Hamburg per web link http://www.cst-container.com/engl/index.html CST Container. This reflects a generic type illustrated in FIG. 1, with longitudinally-spaced, circumferential hoops end tied to a base frame rail, door access end bracing.

[0005] Generally, it is well established to use shipping containers and trailers for transporting liquids such as wine or water. To achieve this, a flexible plastic bag called a ‘flexi-tank’ with filling aperture is pumped full of the liquid by passive gravity and/or over-pressure boosted supply feed. Typically such a bag fills the whole floor space of a 20 ft shipping container and rises to about 3/4ths of the 2.4 m high internal height of the container. Once filled, the tank is supported on the floor of the container and means, distends or bulges outwardly upon both the ends and sides of the container. The container sides are constructed from corrugated steel sheets which are fairly tough, but under the relentless pressure of the liquid in the tank already bulge outward even under static pressure. It is estimated that under static pressure alone the sides have reached 50% or more of their elastic limit. Handling and transport loads, along with dynamic accelerations of stopping, starting and turning, will add to this, and exacerbate risks of permanent distortion or deformation and even structural failure.

[0006] Containers are carried worldwide and a archetypal journey for a container with a flexible tank might transport it on the rough roads of wine growing areas, onto a rail wagon with all its slanting and fatigue vibrations, lifted rapidly on to a ship to receive rolling and tipping motions for several weeks, and then off the ship again perhaps receiving a heavy impact onto the quay side, and then again off along the surface transport to the bottling plant. So, although the bag tank is sometimes lashed to the container and fully filled to the capacity of the bag so that the plastic skin of the bag is taut, it is found in service that the liquid on the top of the bag is able to move relatively freely, to the extent that enormous forces can build up in rapidly moving waves within the bag, resulting in excess pressures on the end and side walls of the container sufficient to bend them outwards permanently. Similarly, when lowering or dropping the container down onto a concrete quayside, the concrete does not flex and nor can the container floor as it impacts the quay, with the result that the only place for the moving liquid to go is outwards into the side and end walls once again, and thus causing damage to the container. Front end walls and doors of containers are often reinforced by the addition of steel or wooden frames to reinforce them against the surging liquid. But the side walls suffer as well, and these are not easily reinforced.

[0007] The dynamic forces involved are large, indeed able to permanently bend and deform the side wall structure and so need countering by restraint in ways quite different to say solid bulk cargo, or liquids which are in effect bottled up in rigid or semi rigid containment.

[0008] It is not just damage of the container that is a problem. Surges and displacement waves within the liquid cause instantaneous pressures, which act on the filling and discharge valves of the tank, finding any weak path in the gaskets and joints causing them to leak. It would be desirable to dampen or suppress such motion before it reaches significant damaging levels, such as when reinforced by standing waves arising from liquid reflected back from tank walls braced by a surrounding container.

[0009] The liquid surges also displace the tank skin, which rubs, abrades and catches surface irregularities or projections on the walls of the container, leading to other potential leakage events. Typically, the internal surfaces of containers suffer normal wear and tear from the transport of general cargo and become snugged, dented and roughened. So it is normal to line the floor, sides and ends with some sort of (‘clean’) intermediate barrier layer, such as corrugated cardboard, to protect the relatively delicate skin of the tank from the harsher surfaces of the container. Containers have lashing hoops located along the internal top and bottom side rails which can
be used for lashing cargo. However the liner obscures the lashing hoops fitted to the bottom side rails leaving only the top rail hoops accessible for lashing. The cardboard is not re-used and has a cost of fitting and disposal, which adds to environmental damage costs as well as commercial.

[0010] It is a commercial reality that the more cargo that can be carried in one consignment, the lower the handling and transport costs. However, liquid payload limit, of typically 24000 kg, has already been reached and arguably exceeded; being that which causes unacceptable damage to a number of typical freight containers. Some way to increase payload, without further container damage, would be desirable.

[0011] A common flexible tank construction is of welded plastic sheet, some 1 mm in thickness. The skin cannot be made tougher because it would resist forming itself to the shape of the container and so lose the benefit of bracing and support by the container floor and side walls. Thus the bag either has to be very flexible, or very strong, that is as strong a steel tank container. Being so thin, the skin of the tank is vulnerable to local contact imperfections, projections and discontinuities or surface abrasion and so not conducive to being cleaned before filling the tank with another liquid. So, to avoid cross-contamination, the bags tend to be destroyed and re-cycled. Market competition means the cost of the flexible tanks has to be kept low. So a bag containerisation system which makes use of commercially available flexible tanks would also be desirable. Some way to dampen, suppress, regulate or otherwise control liquid surges, protect the container from impact damage, ‘bund’ or contain leakage in the event of inner tank failure, increase payload, and enable greater re-use of materials would also be desirable.

STATEMENT(S) OF INVENTION

[0012] In the present invention, a flexible bag or tank is configured for containerisation, that is use within otherwise standard container confines, so that upon fill the tank is supported by container floor, side walls and end structures, but with a top surface clear of the container roof and so accessible to some form of damper, buffer or restraint provision, such as through external bias, loading, baffle or displacement for local re-shaping to help discipline dynamic behaviour of liquid contents under load. The damper or baffle action can be through a top wall or bag skin, from outside and/or within, with inhibition of baffle movement to preserve baffle calming, damping or suppressing action.

[0013] The tank wall could feature integrated longitudinal and circumferential pockets, conveniently bounded by stitched or welded seams; with optional insertion of stiffener rods, cables and/or restraint ties. A re-entrant local bag profile, through ‘tuck-in’ seams of the bag wall, might be contrived, to receive elements of a bounding support frame. It might then be unnecessary to tie the bag to an external brace or frame. As an example more elaborate variant spiral-wound, stiff but flexible or compliant, draw-through wire (such as used in small bore drain cleaners), could fit within elongate bag wall pockets; and, with a rotatable crank drive handle (manual or motorised) at one end, co-operating with an opposite end screw traveller, operable to draw in or unwind, be deployed as an adjustable binding constraint or clamp; with the option of positive end tie of the wire ends to an external support frame; this might be more manageable than, say, a simple draw-string and end tie.

[0014] Generally, particular attention is paid to a tank upper regions and a top surface of liquid content, where the more problematic liquid movement behaviour arises, and to mutual interaction with container upper regions to impose discipline. Thus, from operational considerations, a flexible tank bag occupying an entire container internal volumetric capacity would, when filled with liquid, take the loaded container beyond approved weight limitations and make the container unwieldy to handle, let alone lift and stuck to be safely supported by other underlying containers without distortion and damage. So in practice a hitherto unused and wasted or dead ‘headspace’ volume (necessarily) arises within container confines above a flexible tank.

[0015] In one aspect of the invention, the Applicant seeks to put to constructive use what would otherwise be such wasted space within a container above a flexible tank, by fitting a buffer or damper to suppress unwanted upper body and surface movement of liquid in a flexible tank.

[0016] An intermediate liner between closed wall flexible bag and a rigid container base and wall, leaving the roof unstressed, would provide a secondary containment or so-called ‘bund’ within container confines in the event of local bag failure or leakage. The liner wall, or at least an upper portion, largely above the level of liquid content in an internal flexible bag tank, might also be used as a part anchor for a movable damper or buffer, in liquid contents damper or buffer measures.

[0017] So broadly, a headspace damper or buffer operative could be between a container upper body, such as roof and/or upper side walls, and an upper surface of a flexible bag tank. Moreover, a headspace buffer mounting, at least at one side, could use an intermediate containment liner or bund membrane, such as of open-top configuration, accommodating a discrete flexible tank.

[0018] A simple buffer format would be a series of local diagonal ties across the bag top wall or roof; These would not need to be wholly circumferential, as with known bag straps of U.S. Pat. No. 6,186,713, as it is primarily the upper fluid body and free ‘slooshing’ surface behaviour that is of concern. So a ‘layered suppression’ or ‘upper tiered’ approach is more useful and effective against this.

[0019] One ‘passive’ buffer format might be one or more inflatable tubular beams, bags or bolsters, straddling transversely and/or longitudinally over a flexible bag tank, between opposite container walls, and/or an intermediate liner. A more ‘intelligent’ or proactive, disruptive or anti-phase, interactive baffle or damper could feature intrusive, intervention elements at positions across the flexible tank span corresponding to anticipated liquid wave motion to be damped or suppressed. Thus, for example at wave nodes, such as displacement peaks, and/or to break up a coherent wave front into lesser, or less disruptive waves, in the manner of say a beach tidal breakwater.

[0020] An example would be a series of local depressions, extensions or intrusions from the inside of the container roof toward an exposed liquid surface within an open top tank. To counter lateral surface wave motion, a series of spaced concerto-folded, or corrugated former bands or strips could be spread at longitudinally-spaced intervals, spanning the container width. An adjustable profile former, such as a malleable plastic or folded metal or timber sheet, or one mounted more adjustable concertina fold or corrugation density, could serve this purpose. It might be, subject to study of surface wave behaviour under container acceleration, that straight strips disposed diagonally or longitudinally would suffice as an alternative.
A ‘floating’ flat or contoured panel or board, tethered at opposite sides to an upper container and/or liner wall might suffice, provided the tether allowed for adjustable tension, and possibly also some element of diagonal cross-brace disposition, to counter wholesale lateral movement of liquid within bag tank confines. A co-operative folding shutter panel array might be contrived to counter particular unwanted liquid behavioural modes, by offering variable degrees of damping or suppression by tighter or slackier local or overall confinement. A certain local ‘escape’ or exhaustion of liquid energy could be admitted by allowing local bag penetration squeezed between successive shutter panels. Shutter slat section could be flat or shallow curved to achieve desired flow re-direction.

One or more longitudinal buffers might suffice to regulate lateral liquid motion; say at mid-, one third or quarter transverse span. A wavy (say, sinusoidal) profile, longitudinal depending buffer panel or plate, or series of platelets, might be used to counter different phased displacement modes arising along the tank length. A demountable, and optional collapse-fold, internal lattice or space frame could be deployed, to hang from container walls or existing side lashing points, for fixed or adjustable disposition and/or orientation buffer or damper panel carriage. An open top bag liner could feature an upper peripheral edge draw string, threaded through a circumferential array of eyelets, allowing different threading patterns, including cross-lacing to reflect the nature, degree and locality of local bag upper level constraint. Multiple layered or staggered rows of threading eyelets or eyelets, set at different levels, could allow a layered diagonal interwoven matrix, in the manner of a knitting or sewing cradle, to create a robust but flexible binding and restraint membrane, with intervals to allow intervening bag tank wall bulging penetration. An intermediate (load) spreader membrane, which itself might be pre-formed into, say, a shallow dome, contour, could be interposed between tie cords and upper bag tank wall to obviate local clashing. Again, the entire upper surface may not need to be covered, rather one or more local movement suppression patches. The emphasis is upon addressing the mobilility of liquid tank bag content.

Although, for reasons of economy and ready sourcing for replacement, there is a case for a well-rehearsed ‘standard’ format bag tank, more elaborate bespoke bag tanks could be contrived, but adapted for liquid content, rather than hitherto known bags for solid fill. Thus, for example, more ‘layered’ in- and/or over-folded bag, such as by repeated progressive manipulation of a simple(r) bag starting point, including, individually or in combination:

1. a spiral ‘swiss roll’ bag format, with multiple bag pre-fold, to create inter-nesting annular cells;
2. a convoluted fold bag; again with pre-fold to double-up or more;
3. a concertina-fold bag, again with initial repeated over-fold, for more bag layers;
4. a bag turned partially inside-out, to create multiple overlaid bag wall skins;
5. A. an axial twist bag, to fur/ufurl,upon (liquid) contents fill/empty;
5B. a mutually intertwined spiral twist bag;
6. A sub-divided bag volume would itself dampen or suppress altogether wholesale fluid contents motion. Within a common container multiple subsidiary bags of a similar or diverse kind might be included, to nestle alongside one another; possibly with interconnected ports in respective bag walls. Thus in a bag mix, conventional simple bags could be combined with more complex forms.

A lightweight rigid tube, say 100 mm diameter thin walled material, disposed transversely of a container (8’) width and superimposed upon a bag tank upper wall could serve as a damper, with multiple longitudinally spaced such tubes along the container length. A tube could interiorly nestle into container and/or liner side walls or be suspended from tie cords or a supporting adjustable throat carrier frame. Paired opposed tubes upon upper and lower bag tank walls could be mutually tied by tension cords; and could be allowed a certain shared, tethered mobility.

Other baffle or damper formats could address the bag from opposite sides, such as to capture and squeeze locally between top and bottom with mutually entrained elements. A sub-divided liquid load in discrete segmented juxtaposed flexible tanks can be more secure, in the sense of more redundancy or less risk per individual bag failure, but a compromise needs to be struck with ease of fill and discharge and minimizing spillage losses, let alone theft losses. Selected bag tanks could be filled on demand and others left collapsed and deflated until then.

Multiple individual, but mutually tethered, baffle stiffener slats could be joined to or integrated with a bag upper wall, say by stitching or bonding and could feature threading holes for through pull of tension cords or ties extending to the container or bag liner outer margins. Inter-threaded, mutually-entrained slats orientated transversely across the container width, could form both an adjustable contour flat or curved damper plane and a flexible upper access walkway for operatives, rather like the platform of a rope bridge, but with supportive underpinning of a liquid-filled bag body. Generally, the nature, disposition and (inter-)action of baffles reflects the intended bag tank contents. In this case liquid is a prime requirement. Other materials, such as flowable powders, granules or pellets, have different considerations and may prove less mobile than liquids.

For safety considerations, access to a tank within container confines is not acceptable once tank bag filling has commenced. Thus any external tank restraints must be deployed preparatory to bag fill. To this end, automatic restraint deployment could be fitted.

EMBODIMENTS

There follows a description of some particular embodiments of the invention, by way of example only with reference to the accompanying diagrammatic and schematic drawings, with some simplification and informality in style for ease of illustration, and in which:

FIG. 1 shows three-quarter 3D perspective ghosted view of an otherwise standard format container with internal flexible wall tank disposed as an internal liner for liquid storage;
FIGS. 2A through 2D show variously longitudinal and cross-sections of the tank of FIG. 1 and the behaviour of liquid content in the flexible wall tank bag under shunt and cornering loads;
More specifically . . .
FIG. 2A shows a longitudinal section of a static unloaded (aside from its own passive weight and that of its liquid contents) bag of shallow domed form, sat snug within container longitudinal confines but with a gap overhead between respective bag and container roofs;
FIG. 2B shows the bag of FIG. 2A under sharp declarative braking load, with a bow wave engendered in the liquid content and reflected in characteristic tank bag wall deformation, with attendant loading upon container end wall;

FIG. 2C shows a sectional view of a low-profile, flat-roofed tank bag with with perimeter clearance within container confines;

FIG. 2D shows a transverse cross-section of pressure profiles upon tank bag transferred to container side walls; that is lower at the top, higher at the bottom;

FIGS. 3A through 3F show cross-sectional views of the containerised tank of FIGS. 1 and 2 fitted with various internal baffle configurations of the present invention;

More specifically . . .

FIG. 3A shows a ghosted 3-D perspective three-quarter view from one end of a flexible tank with an intermediate perforated baffle wall over the entire local cross-section;

FIG. 3B shows a variant of FIG. 3A with a matrix mesh format intermediate baffle wall;

FIG. 3C shows another variant of FIGS. 3A and 3B with a waisted format intrusive intermediate baffle wall creating a local constriction or throat for liquid content, which inhibits its longitudinal mobility within a tank bag;

FIG. 3D shows a sectional view of a variant of FIG. 3A with a stepped local tank section of somewhat reduced height;

FIG. 3E shows a view along the line A-A in FIG. 3D depicting deflected internal flow;

FIG. 3F shows a plan view of FIG. 3E showing hour-glass profiled, local section waist, as a restricted flow section throat;

FIGS. 4A through 4C shows, viewed from let to right, variant multiple internal baffle dispositions of the invention;

More specifically . . .

FIG. 4A shows a ghosted part cut-away view of a flexible tank with twin spaced perforated baffle walls;

FIG. 4B shows a more complete view of FIG. 4A showing liquid containment;

FIG. 4C shows a variant of FIG. 4A with inclined baffle walls;

FIGS. 5A and 5B shows a series of longitudinally spaced external ties for the flexible tank of FIGS. 3 and 4, with optional rigid tube bolster overlays and their capture with ties;

More specifically . . .

FIG. 5A shows a ghosted 3D perspective view of a flexible tank bag with a longitudinally spaced series of local peripheral or perimeter binding ties to create an indented, or part-segmented or compartmentalised profile between local external restraint; as bag sides and ends are already constrained laterally by contact respectively with container side walls and ends, the principal effect of the perimeter ties is locally to constraint the bag tank upper wall, allowing distention or bulging between ties, as surge suppression measures;

FIG. 5B shows a completed view of FIG. 5A in container confines, with liquid contents in a bag tank with an upper surface locally constrained by transverse beams or bolster, themselves mounted to and braced against the container structure, conveniently upper side rails;

FIGS. 6A through 6F show cross-sections of a flexible tank in a container under various load conditions;

More specifically . . .

FIG. 6A shows a sectional view of a container with collapsed flat internal tank bag;

FIG. 6B shows another sectional view of a container with a circumferential tie juxtaposed with a collapsed tie;

FIG. 6C shows a further sectional view of a container with inflated bag filled with liquid content, but with no liner;

FIG. 6D reflects the FIG. 6C construction, with peripheral or perimeter tie straps which squeeze the tank bag into a different profile to form differently shaped local constriction baffles;

FIG. 6E shows a still further sectional view of a container with external restraint ties with opposite ends secured to a container frame;

FIG. 6F shows a sectional view of an overlaid transverse tube locally indenting the upper wall of a tank bag; but with no liner;

FIGS. 7A through 7D show peripheral or perimeter lashing and restraint tie wrap bands or cords, with optional interlaced cross-bracing, for the tank of FIGS. 3 through 6;

More specifically . . .

FIG. 7A shows a ghosted 3D perspective three quarter view of a container with multiple round flexile tank set within an intermediate liner;

FIG. 7B shows a sectional view of FIG. 7A with positioning of slack circumferential ties and liner, with respective ends secured to upper container frame disposed over a collapsed underlying tank bag;

FIG. 7C shows another sectional view of FIG. 7A with underlying bag inflation and fill within a liner and an overlying tie wraps tensioned to shape local tank profile and form local constricitions which serve as baffles to inhibit longitudinal fluid movement; the unrestrained intervening tank profile and liquid contents being depicted as a backdrop to the top profile;

FIG. 7D shows further sectional view of FIG. 7A with perimeter tie wraps (re-)disposed to achieve a more rounded, less peaked, top flexible tank profile;

FIG. 8 shows local scrap section of a folding tank;

Referring to the drawings, some considerable simplification for ease of illustration and comprehension has been used, with selective local detail and omission.

Thus, reflecting current practice, FIG. 1 depicts a typical flexible tank, commonly referred to as a ‘flexi-tank’ 1, which is essentially a large (distended or inflated) bag or balloon formed from a thin synthetic plastics skin side walls 2, top 10, floor skin 13 and end skin 14 with a loading/ discharge valve port 3 welded to the skin 14 at the end nearest the container doors 9. Port capacity is sufficient for rapid fill and discharge flows and can feature self-venting against air lock formation which might otherwise impeded full flow. The tank 1 is located within and largely fills the otherwise empty internal void confines of a typical shipping container 21, shown with roof 43 removed and near sides 6’ ghosted to reveal the tank 1 inside. Once filled with liquid 4, such as wine or water, latex or paint, tank 1 takes up the shape of the side walls 6 of the outer bounding container and front end wall 7, and doors end structure 8, but may not contact the roof, leaving a headspace 75. The side walls are typically made from robust some 2 mm thick corrugated steel sheet. The doors 9 are shown open for viewing. A temporary confinement or containment structure 8 of removable planks or beams is provided to support the end of the tank, both statically and dynamically, during transport and protect operators from a potential of tank 1 bursting out through the doors when
the doors are opened to gain access to the valve 3 for discharging the liquid contents 4.

[0077] When the tank is properly filled and the container is at rest, the side walls 6 are pressurised and distended sufficiently to push them outwards by more than 10 mm, with a load which can represent up to about 50% of the yield strength of the side walls in local zones. The liquid 4 in the tank 1 presses the sides 2 and ends 14 firmly against the walls 6 and floor 13 and structure 8, so that even in severe movement of the container, they remain in contact. However, the top skin 10 of the tank 1 is free to deflect, being unsupported and unconfined by any structure and of smooth natural shape.

[0078] FIG. 2A shows a side elevation of the tank 1 at 'rest', or not subject to dynamic loads, in an outer container 21. The skin 10 becomes tight after filling and cambers up from the sides and ends when properly filled. However, liquids cannot be made to act as stable solids and the typical 1 mm thick plastic skin 2, 10, 13, 14 is no match to secure against the surging of liquid 4, typically weighing 24 tonnes, in transport and handling. The slightest acceleration or deceleration of the container in manoeuvre causes the liquid to form waves 27, 28 under the skin 10, moving up and down the length and breadth of the container at alarming speed and intensity, sufficient to damage the container side walls 6. As the surge moves towards the front end 7, the depth of the liquid 4 increases at 4° and decreases at 4°. Reflected back standing waves of progressively reinforced amplitude can arise.

[0079] On the railways, such surging occurs regularly and the liquid 4 not only rises up as a wave 27, but will naturally encounter the rigid front end wall 7, whereupon the energy built up in the liquid must be dissipated. It seeks the path of least resistance, which has been found to be the lower part 6° of side walls 6. The skin 10 of the tank can do no more than follow the forces of the moving liquid within, leaving the side wall alone to support the liquid. Very quickly the reaction to this forward motion sends a wave of liquid back down the tank 1, to encounter the structure 8 at door end 5 of the container 21, often with accelerated motion and greater force and more waves 27, only to return to the front wall 7 again. The drama of these waves has to be observed to appreciate the magnitude of the attendant forces; but suffice to say the dynamic forces involved are sufficient permanently to bend the container steel side wall structure.

[0080] FIG. 2C shows an end elevation of a container with general cargo 29 inside barely touching, if at all, the side walls 6 of the container and in FIG. 2D a container in section with a tank 1 in situ. Although much of the container damage from flexible tanks results from longitudinal movement and surge of liquid content, another loading event takes place when the container 21 is lowered down onto a typical concrete quay side 32. Container cranes lower such containers rapidly and the heavier the container the more rapid the decent. A limit of 2 g vertical acceleration is used to calculate and construct the strength of a container, but this relates to the structure of the floor 28 of the container and assumes a rigid non-fluid cargo 29, perhaps not even touching the sides 6. However, when a cargo such as a liquid in a flexible tank is lowered onto the quayside 32, the liquid 4 naturally seeks the route of lowest resistance. The floor 28 cannot give because of the concrete quay. The ends 5, 7 are capable of taking heavy impacts. So it is the sides 6 which must absorb the impact energy and often bend permanently.

[0081] FIG. 2D shows arrows of a profile which illustrate the magnitude of increasing pressure 33 in the liquid 4 acting on sides 6. The pressure goes from zero where the top skin 10 shapes away from the side wall 6 to a head of some 2 metres at the floor 28. With a vertical impact load, the pressure profile is similar, but of greater magnitude, and unsurprisingly, when a side wall 6 bends permanently, it is nearer the floor 28 than the top 10. However, the liquid 4 in the top of the tank 1 in a cambered zone, which statically is restrained by tension in the skin 10, moves under vertical impact to flow and raise the pressure on the sidewalls 6, but acting at a height now greater than before, further straining the side wall.

[0082] If the tank 1 could be filled so that the top skin 10 were close to or touching the roof 43, a surge wave would not be developed, due to the restraining effect of the roof structure. However, filling to the roof of the container implies a volume of liquid such that the weight would exceed the lifting capacity of the container. Furthermore, the height of the liquid up the side wall would increase the static and dynamic pressure on the side wall to such a degree that it would bend the side walls.

[0083] FIG. 3A shows a sectioned part of a tank 1 of one implementation of the invention, in which inside the tank 1, and connected to inside of the skin 2, 10, 13, 14 is an intermediate perforated baffle wall 22, comprising a peripheral edge 20 and tensioning means between one edge and another.

[0084] There are several ways to make such a baffle. One might be an open-framed net 23 woven from a series of tapes or strips 24 as shown in FIG. 3B, or as in FIG. 3C, a sheet 25 profiled at 10° to match the top 10 and 13° to match the floor skin 13, with a member 26 joining the top part 25° to bottom 25° or even a semi-rigid rod with flexible joint or hinge mid-way along its length or rope. Common to all these baffles is that they are fixed to the inside skin of the tank at all or part of the peripheral edge 20, and have gaps, holes, or spaces 17 available to the liquid to enable the liquid to pass by or through the baffle.

[0085] A further form of baffle 93 envisaged is illustrated in FIG. 3D and 3F, in which in manufacture the top skin 10 is pinched and welded at weld 90 to form its peripheral edge 20. The excess skin 91 might be discarded or retained. If retained, the skin 91 further adds to the baffle effect, as denoted by arrows 92 in FIG. 3E, indicating the curving liquid 4 flow path from one side of the baffle 93, 91 to the other. Such internal and external baffles could be used selectively in combination.

[0086] Referring again to the high pressure experienced at the bottom of the container side wall 6 near to the floor 28, the profile of the baffle such as 22 should ideally follow the shape of the natural filled tank skin 13, 2 near the floor 28, so as not to pull or distort the skin 2, 13 and become overloaded and tear.

[0087] The baffles are made of a similar flexibility as that of the skin 2 of the tank 1. So, as shown in plan section in FIG. 3F, as the liquid 4 surges through the apertures 17 in baffle 9, it causes it to deflect and the pressure of the flowing liquid generates tension in it, thereby tending to pull the skin 2 inwards in a direction away from the side walls 6 of the container, thus relieving the side walls from some of the pressure caused by the surging liquid. Similarly, the otherwise unrestrained top skin 10 is restricted in movement, being held down towards skin 13, thus reducing any wave motion which might be set up by the motion of transport and handling the container. The sheet 25 in FIG. 3C is specifically designed to hold top 10 from rising upward.
The location, orientation and number of the baffles can be chosen to suit the requirements, the size and shape of the apertures, holes, etc. of the baffles can be chosen according to the amount of restriction desired. The container side and end walls have considerable strength, so it is desirable to limit the activity of the liquid to a degree sufficient to be within the limits of strength of the container, albeit not to remove all load from the container. It has been found that, only by experiment and trial and error, can the right balance be found between restriction of liquid movement and container strength be determined. Such is the complexity of combining the dynamics of the surging liquid with static pressures to a container structure which itself varies in design and capability. The force on the baffle of a tank filled with say 24 tonnes of liquid and having impact accelerations on rail of 3 g is estimated to require a 12 tonne force in a full perimeter connected baffle such as 22.

It has been proven through trial and experimentation that, by restricting the surging of the liquid 4 during vertical, transverse and longitudinal transport accelerations, the end wall 7, sidewall 6 and door end 5 have a reduced pressure exerted upon them when baffles are provided. It is not just the force which must be supported, but also the deflection of the bag. FIG. 23 shows the movement of top skin 10 from location 10 to 10" at the door end, which represents movement of the tank skin over the sides 6, leading to wear and tear of the skin. Pressure build up at the door end when the surge returns in this direction has a detrimental effect on the valve 3, which can lead to leakage.

Since these are every-day sturdy containers, it is undesirable to make special cargo container simply for this relatively small use of carrying flexible bag tanks for liquids; rather it makes commercial sense to try to prevent the tanks from damaging the container sidewalls 6. In variants of the present invention, the baffles 9 can be sited at any location, incline or shape along the length or width of the tanks, as shown in FIG. 4. One beneficial location features a rectangular baffle 41 nearby the location where the permanent bending occurs, near the end walls 5, 7 and low down on the sides near the floor 28. In this way the baffle holds the otherwise swelling tank in at a buckle zone, preventing the ultimate bending load from being reached. It is envisaged that the baffles 40 can be made rigid and/or narrower than the internal width of the container. Thus, as the impact on the quayside causes the liquid to push out sideways, the baffles 41 go into tension and restrain the liquid from pressing onto the side walls 6 in the locality of the baffles 41. It is envisaged that the baffles 42 be aligned at an angle, or indeed be aligned horizontally, such that the sides of bag cannot travel outwards, at least so far as to cause the side walls to take all the pressure from the liquid. More than one horizontal baffle is envisaged. The baffles are to be perforated to allow the controlled flow of liquid from above and below to move.

In another embodiment shown in FIG. 5A and 5B, a standard flexible tank 1, 50 of the invention is loaded into a container 21. Around the tank 1, 50 is shown tension or confinement provision, comprising a closed (or alternatively only partly circumferential) loop of three straps 51, which are shorter in length than the perimeter length of the tank skin at the location where the straps are located. As the tank 1, 50 is filled, the skin 2 swells up to a height until the straps 51 have reached the end of their free movement. With any filling after this point, the straps 51 begin to tighten upon the tank 1, 50 and in this way, the straps form a local (constriction or constraint) and effective baffle 52 within the upper part of the tank 1, 50. An end elevation in section is shown in FIG. 5B revealing how the skin 2 rests on the sidewalls 6, yet the strap 51 pulls in the skin 2 near the top 10 to 21, 10 and thus reduces the cross-sectional area of the tank 50 to form the baffle 52. It is not necessary that the straps 51 are so tight as to pull in the sides of the tank 1, indeed it can be detrimental to the skin 2 of the tank 1, causing tension and pinching of the skin 2, and introducing a surface insufficiently supported by the structure of the wall 6. Rather, it is only required that the unsupported skin 10 be constricted locally and re-shaped where the surging liquid 4 moves most freely. The result of this is that, as liquid 4 surges along the tank longitudinally, particularly near the freer moving upper regions and liquid surface adjacent to top 10, it is diverted by the baffle 52, resulting in a reduction of the surge. The weight of liquid 4 and the friction between tank 51 and sides 6, floor 13 holds the straps 51 down against the forces in the liquid due to the surge. A further action occurs when the container 21 is impacted down onto the quayside 32. The resultant sideways pressure 33 of the tank 50 on the side walls 6 is reduced by some of the force being restrained by the straps 51.

An alternative or supplement to external peripheral or perimeter restraint straps 51 is shown toward the front of the container 21 as a structural member 57 within a headspace 75 between top 10 of tank 1 and roof 43. In this example member 57 is formed as a rigid metal tube, running transversely across the top of the tank 1 and pulled down with straps three 58 (one on each side and one connecting the straps under the tank 1) so that when the tank is full as shown, the member 57 indents the top 10 of the tank to form again a baffle 52.

In FIG. 5I the straps 51 have been dispensed with and member 57 is seen tied to flaps 71 formed externally as part of the tank 1. The member 57 has two ends. Flaps 71 are to be located and fixed to the tank 1 in end locations of the member 57 as required so that a number of members might be used to indent the top 10 of the tank and form baffles 52.

An alternative local external bias or intrusion member 72 is also shown in FIG. 5I with struts 59 at either end which are supported underneath against vertical movement by the top side rail 74 of a typical container roof 43 and against horizontal movement by virtue of the struts 72 entering into the valley 73 of the corrugations of the side wall 6. Although shown here as individual members 72, 57, one or more, typically 5 such members are deployed along the length of the tank 1. The members can be connected to each other to form one larger structure and thus support each other to a degree as a surge wave encounters one or other of the members.

Once the tank 1, 50 is being filled, no personnel can enter the container. All straps, flaps, hooks, tanks, liners, baffle members and the like must be (pre-)set correctly, so that as the tank fills, these devices deploy themselves automatically into the desired position.

The number, location, span and circumferential wrap or embrace of the straps can be varied for desired performance, or in the case of a bag in FIG. 7 continual along the length of the wall 6. A prime consideration is discipline by restraint or constraint of upper and surface layers of liquid content. The straps can be manufactured as an integral part of the flexible tank bag 1, or can be made as a separate item, to be freely located, held by friction, tied to loops made within the tank, or tied to the lashing hoops which exist in any
container. The straps might be formed from wire rope, rubber hose, ropes, webbing straps and so on. They might be made adjustable in length or of a pre-determined length. The strength of the strap 51 is envisaged to be of the order 5 tonnes and none too elastic. The straps are envisaged to be of soft material finish, so as to not damage the skin 2 of the tank 1. The straps 51 might be tied to each other via a further set of straps 54, ideally aligned longitudinally to help control surging of the liquid.

Although upper region restraint is paramount, straps 51 can be a partially or completely closed perimeter or peripheral loop and not secured to the container in any substantial manner, so that it is free to take up its natural shape under tension as the liquid moves about. The weight of the liquid keeps the strap on the floor of the container and the friction so developed maintains the location of the strap. This floor location is important when it comes to discharging the liquid and shows a benefit of using a strap of some 2 mm thickness, instead of a rope, cord or cable which might have a 15 mm diameter and cause a small yet significant puddle of liquid to remain in a discharging tank. Even so, the straps 51 might be made from a simple length of rope tied with a knot, ideally before the tank is filled. Or they might be made with a thin webbing strap where it lies on the container floor, and then be formed as a rope where it passes over the skin 2 of the tank, thus allowing no puddles in discharge, yet avoiding scuffing of the pulled-in tucks and creases 56 that occur as the rectangular profiled tank skin is pulled in from 2 to 2'. The straps in another embodiment are provided with ties to tie to the existing container lashing hoops on the bottom side rails, the ties being long enough and/or flexible enough not to restrain liquid surging.

In a further embodiment, FIG. 6A, 6B, 6C and 6D show an section end elevation of a container 21 with roof 43, sidewalls 6, resting upon a floor platform 28. In FIG. 6A a webbing strap 64 lies ready on the floor. The strap has connectors such as rings 65 at each end. In operation, a number of straps, perhaps 3, are positioned along the floor of the container. An empty folded tank 50 is laid out on the floor on top of the strap 64. Before the tank 50 is unwrapped and unfolded, a strap 66 is positioned over it and is clipped to the ends of strap 64 by hooks 67 at each end. FIG. 6C shows the tank 50 filled with liquid 68, the tank 50 being unrestrained and sitting on the floor and resting against the sidewalls 6. In FIG. 6D, should the same tank 50 be filled from 50 and restrained by straps 64, 66, which form a continuous loop around the tank, it would hold the skin 10 and partly 2 in at 10', 2' to form a baffle as described in earlier examples.

It is envisaged that the strap 64 might be formed as part of the skin 2 of the flexible tank 50 terminating in one or more connectors 65. In manufacture, the flexible tank would be made of substantially of uniform section, with no burred areas built in; these being formed as the tank is filled by the action of the hoop 66, 64, which is of smaller perimeter length than that of the filled unrestrained tank. The strap 66 might be part of strap 64 and have just one connector 67, at say the right hand side. Alternatively, strap 66 and 64 might be permanently attached to each other forming part of the tank assembly. The strap 64 if formed as part of the tank might simply be a reinforced part of the skin 13 of the tank.

In FIG. 6E an arrangement of straps 66 and connectors 67 allow the connectors to be clipped to existing hoops 69 available aligned along the side of the roof 43 of typical containers. Straps 66 can advantageously be connected to each other where they cross at 70 when it comes to combined rolling and pitching loads experienced at sea. The strap 64, or its built-in equivalent part of the tank, is best made thin flat webbing and not of a rope, which might lie proud of the floor 62, making final drainage of liquid from the tank difficult, causing puddles to form upstream of the discharge nozzle.

In FIG. 6F members 57, 72 are shown locally indenting the top 10 of tank 1 down to 10', thus forming an effective constraint, damper or baffle 52. The member 72 is retained by the top side rail 77, whereas the member 57 is tethered by flap 71 or straps 51.

FIG. 7A shows a perspective view of a variant with a rectangular open topped box shaped liner bag 81, comprising a watertight bag of plastic sheet 87 filling the whole of the interior space of the container 21 resting easily on the sides 6, floor 28, structure 8 and 7 up to a height close to the roof 43 removed here for clarity. The bag has fitted at end 87 a watertight collar 83 through which the valve port 3 of tank 50 projects and is made watertight to it by known means. In use, the sides 86 of the liner 81 are taped or fastened lightly into place on the sides 6, the folded tank 50 introduced inside the liner 81, its valve port 3 passed through a collar 83 formed and sealed to end 85 of the liner. Straps are seen fastened at intermediate height at 82 to the sides 86 of the liner on each side. As the tank 50 is filled, it rises until the top skin 10 begins to form into an undulating shape forming baffles 84 across the top 10. This is more readily appreciated from FIG. 7C.

FIG. 7B shows an end elevation in section through the container with tank 50' empty and still folded, fastening of straps 80 clipped 67 to hoops 69 available in the container. The tank 50 is then filled as shown in FIG. 7C and the local section constriction baffles 84 formed in the top 10 to shape 10'. Operational features are as already described and surging and side wall loading are reduced to acceptable limits. Indeed it is found in practice that the size of tank 50 can be increased by some 15 to 20% through control of the surging liquid within the tank 50 and container 21.

FIG. 7D shows another arrangement where the straps 66 are inter-connected, or even made as one, but again, as the tank is filled, constricting the rise of top 10 locally to 10' and forming baffle 84.

If a leak in the tank 50 should occur, the liner 81, being taller than the free level of liquid in tank 50 will contain the leaked liquid until the liquid can be discharged safely.

In FIG. 8 the construction of the liner 81 might be additionally reinforced by the addition of other padding or skins, such as bubble wrap 90, to the leak proof sheet 87, so that, should some object such as a floor screw 88 come near to tearing the sheet 87, it is protected from that event. Should a hole appear in the liner 87, it can easily be repaired by an adhesive patch 89 being applied on the inside of the liner; a task impossible to do on tank 1, where there is no access to the interior. In a further variant (not shown), the bulkhead structure 8 can be formed as a wall 85 as part of the watertight liner complete with collar 83. When empty, the liner can be folded up onto the structure 85 and carried and stacked as a palletised cargo might be for returning to base and its re-use.

FIGS. 5B and 6F address bag constraint at upper regions and surface levels of liquid content, using local damping, baffle, loading or constraint provision operative between tank and upper container structure; obviating circumferential wrap ties.

By way of further elaboration and refinement, as cost allows, peripheral tie or restraint cords, straps or bands
can be located in pocket seams. These could be pulled and tied at their ends, rather like ‘duffle’ bag draw-pulls. Conveniently, such ties permeating the fabric body could be continued at their ends to couple with an external bracing and support structure. Alternatively or additionally, tensioned and/or seams in the body of the fabric itself can be used to shape the fabric body envelope profile, such as in a series of necks or convolutions. Elasticated thread could be used for this purpose. Similarly, differential stretch panels integrated into the bag fabric, seam joined, or panel overlaid, say by stitching and/or adhesive bonding or solvent welding, could be used locally to determine the material behaviour under load, such as compliance. Absorbent cushion pads could also be incorporated for local load spreading. A multiple differential entrained panel patchwork quilt style construction could be employed, proved the joint seams sealed, say in the manner of wet suit construction.

[0109] A re-entrant, or contiguous indented or re-entrant ‘tuck-in’, local bag profile can be designed so as not unduly to affect loading fill or emptying discharge. The number and degree of such in-folds can be varied with overall stiffness and rigidity required. Primary and subsidiary bags or bag elements could be conjoined or some wrapped around others. In some respects, priming or discharge of bag subsidiary closures could in some respects be like selective inflation or deflation of an flexible fabric walled air bed. Again consistent with economic considerations, still more elaborate multiple compartmented, segmented or multi-layered bags, say with local stiffener cells, could be contrived. These could feature multiple discrete compartments, such as a series of longitudinally-spaced, circumferential ribs, say in the manner of chest ribs about a common flexible spine of organism physiology, with differential stiffness, to impart a desired fill or inflation and collapse upon deflation modes. Differential materials and/or seams could feature in that.

[0110] An entire hollow space frame lattice tank configuration could be adopted, albeit with somewhat slower fill and discharge rates, either on its own as principal containment and storage, or in conjunction with a more conventional inner bulk tank, albeit one constrained and confined by a bounding flexible frame or collar.

[0111] Elongate deformable bags could be conjoined or interlinked by intertwining, say in the manner of flexible and twistable balloons used to construct 3D shapes, forms, figures or sculptures of contiguous conjoined balloon cells or compartments isolated by local necking of the balloon wall. An example would be a linked sausage format achievable by a series of longitudinally space constrictions or necks in an elongate balloon. This is a starting point for further twisting, folding, bending and other manipulations to achieve another form. Such manipulations commonly effected upon an inflated or filled balloon. Initially separate balloons can be linked or conjoined in this way for more elaborate multi-link, relatively movable or bendable, structures. In a re-configurable fluid storage bag parallel, a flexible wall bag serves as the equivalent of a balloon, with high bag wall or skin material compliance and stretchability without tearing, rupture or other material failure.

[0112] Outer part-peripheral or circumferential bounding restraint ties to a container frame, such as in a ‘cress-cross’ successive overlapping or intersecting shoe lace matrix or lattice style restraint ties, and/or transverse upper bag surface bolster cushions, with respective individual or collective adjustable tensioners or bag compression loading bias, might be adopted individually or in selective combination together. [0113] A dual role of fluid content motion damping or suppression and load transfer to or sharing with a surrounding container frame are jointly helpful to preserving bag integrity. A continual cycle of loading and unloading could undermine that so care would need to be taken with stress concentration points and structural fatigue. This might materialise in local bag wall tears at critical locations.

[0114] Bag re-profile by local constraint or restrain by external elements could contribute towards a stiffer overall bag structure. Fluid content will re-distribute loads evenly and compressibility effects could be disregarded for some content types, in particular liquids. That said, other contents types, such as powders, granules or gels, might admit of local density or concentration increase.

[0115] Bespoke bag formats, such as inter-nested shells, might contribute stiffening, strength and self-damping, but would be more difficult and expensive to construct. Adaptation to containers to house the bags could be temporary and conveniently demountable, such as through quick-release latch fastenings. The latter might be self locking to container frame lashing loops upon restraint tensioning.

[0116] Any local bag contact, not least of a standard proprietary bag, not originally designed for localised restraint, in particular pronounced local constriction or necking, would require careful determination of surface contour, section profile and location or disposition, so as not to impose undue bag contact loads, while relieving or re-distributing the bag and contents load upon container walls.

[0117] If it is desired to use standard proprietary bags for economy of sourcing, the sheet wall stretch, distention and burst failure design loads of those bags could be (re-)assessed; given any pronounced local constriction could stand to create severe local load concentration; that is the installation might risk invalidating any bag warranty, with contents spillage hazard.

[0118] In that regard a wider or more diffuse ‘bag and/or user friendly’ bag restraint, such as a stretch matrix collar, might be adopted; similarly, more bespoke options include:

[0119] a bespoke ‘internal damping’ profile locally-waisted bag, to suppress longitudinal and/or lateral contents surge;

[0120] a ‘sausage-string’ bag configuration as above, with a series of local load transfer restraint ties from bag constrictor waistings seams to a container (upper bounding) frame;

[0121] a continuous ‘rolling or roll-over section’ sleeve restraint tie, to engender rolling contact with a standard bag, to inhibit local friction; and to distribute local constriction loads over a wider bag surface area.

[0122] Restraint ties might embody one or more progressive gradual twists distributed over or along their length or span, such as a Mobius strip configuration. This to allow flat tie to bag contact surface with a re-orientation of the tie to engage an container frame or a tile loop with a different mounting orientation in that frame. Ties could themselves stretch for self-tension or as a fail-safe measure against gross over-loading.

[0123] For internal fluid movement any cross-section change might act as a local venturi or throttle, with attendant effect upon internal flow velocity and pressure. Restrictions can be used constructively or pro-actively to advantage to serve as damping nodes and/or to convert inertial motion into stationary standing waves, with less adverse dynamic shock impact upon bag and container bounding walls.
[0124] In a bespoke or modified bag, internal ties might be inserted collapsed such as through a filler or discharge port and then erected with local bag wall portions captured or entrained to serve as an internal containment. These might be substituted for some or all external restraints or ties or a combination of internal and external constraints used, with selective outreach to a container frame, such as internal load restraint tie loops.

[0125] A flexible, resilient filamentary internal lattice matrix or strand jumble, such as of inert plastics material, might serve to allow temporary collapse for insertion through a bag port, followed by reversion to an expanded format. Metal inserts or strands embedded in the plastics filaments in such a structure could be engaged, captured drawn or pulled from outside the bag confines to the container frame and entrained or tied locally.

[0126] A bespoke flexible bag or liner would allow integration of bag wall contours, as for periodic local waist constriction along the length. Similarly, local bag wall extensions and/or reinforcement could be tied to an outer bounding container structure to transfer bag and contents dynamic loads to, say, an upper container frame. Even static contents weight loads could be transferred and shared in this way, with a certain proportion of load suspension. Such integrated bag wall tie, bracing and tether provision could be used in conjunction with external ties or could substitute and obviate altogether external measure which might be cumbersome and intrusive obstructions in some circumstances.

[0127] A unitary bag, with appropriate contour, either at the outset, or by subsequent intervention, such as integrated peripheral or circumferential draw-ties within pocket seams, has potential advantage in uninterrupted capacity and possibly in installation and demounting. However, that very open capacity has an attendant vulnerability of unimpeded wholesale contents motion. To counter such motion, without undue adverse restriction on contents fill or discharge rates is a challenge. A fragmented, such as sub-divided, bag might serve, given rapid joint or collective fill and discharge provision.

[0128] A multi-cellular bag might be contrived either within a common shell or as discrete severable elements. A modular modular subsidiary bag cell approach could feature respective individual or shared fill and discharge ports. A bag cell might be configured in relation to, such as profiled around one or more ties to a bounding frame. An example would be an elongate bag with one or more ties through or around it. In that regard an appropriate local bag reinforcement might supplement or substitute for separate ties.

[0129] A more elaborate bag configuration could be adopted, paying attention to the confines in which it is to be located and the external support and/or bracing points available. Thus, say, a cruciform bag might incorporate, secure to or envelope diagonal restraint ties across a container frame, such as between upper and lower internally exposed frame rails. A cruciform profile might be orientated transversely and/or longitudinally of a container body housing. Suspended bladder bag formats with umbilical limb tethers could thus be contrived.

[0130] Local restraint tension for circumferential constriction could differ along a bag length according to anticipated contents motion. Restraint tie tension could be adjustable dynamically in response to actual or anticipated contents load. Tie tensioners could be interconnected for co-operative variable constriction action. That is the ties could act in conjunction with one another, taking account of actual or prospective load movement and loading circumstances. A certain controlled mode of regulated contents motion, such as a progressively moving bulge or wave, could be contrived. This would be less volatile than for unconstrained contents.

[0131] Incipient or actual contents movement might itself be used constructively to initiate or effect local bag constriction at, downstream or even upstream of the start of motion. Contents movement in a constrained environment might create a local pressure surge which can be redeployed to charge a tensioner actuator for a restraint. Alternatively, or additionally, pressure might be fed along bag conduits to (say, downstream) ports to a restrictor priming or trigger chamber, to engender a local flow constricting to the prime bag contents.

[0132] Effectively, a self-re-profiling bag could contrived, with contour or shape continually and promptly responsive to contents motion and attendant loading circumstances, this to achieve a self-damping internal behaviour and one to distribute and cushion load transfer to a surrounding container envelope structure.

[0133] Whilst a container frame may be a locally more robust part of an overall container structure, intervening infill panels, such as roofs, walls and floors contribute some stiffening and rigidity, such as to inhibit frame deformation, bulging, collapse, distortion or lozenge about corner joints. Container handling points are stronger locally and offer points or local regions for bag and contents load transfer. Bag and contents bulk might contribute mass, inertia and stiffening, but load transfer should desirably reflect inherent container structural factors.

[0134] There is considerable knowledge of fluid so-called ‘sloshing’ behaviour in containerised confines and of dynamic modes of fluid behaviour. A container, in particular a flexible bag, shape can have a role in this. Thus the Applicant envisages a helical or spiral wrap elongate bag form to suppress lateral and/or longitudinal fluid contents motion under dynamic loads, but without inhibiting fill or discharge rates. A variable thickness bag wall for differential stretch could also be used.

1. A flexible walled tank or bag (1) disposed within a container, for transport and storage of liquid, and configured for support, upon fill, by a container floor, side walls and end structures, with an overlying headspace (75) between a tank top wall, upper layer or bag skin and a container roof, and local damper, buffer, loading or constraint to achieve baffles (22) operative upon the tank wall and underlying liquid content.

2. A flexible tank of claim 1, with internal baffles formed by local bag wall contour displacement constraints, an upper layer of the tank having in-turned depending portions.

3. A flexible tank of claim 1, with external tensioners between bag and container structure operative at upper levels and between opposite sides as cross-bracing.

4. A flexible tank of claim 1, with elongate tensioners on each side disposed to criss-cross over the tank for fastening to container lashing hoops, located on opposite container top side rails.
5. A flexible tank of claim 1, in which a tensioner comprises elongate webbing or rope passing under a tank body and around to upper fastening points of container body or structure.
6. A flexible tank of claim 1, in which an elongate tensioner is secured at one end to the tank at a point below the top surface.
7. A flexible tank of claim 1, with mobile external local bearers for local bag wall indentation and restraint.
8. A flexible tank of claim 1, with baffles formed, deployed and tensioned upon tank fill.

9. A flexible tank of claim 1, with an in-turned skin portion forming a tank baffle and/or local reinforcement adjacent to an adjacent tank wall indentation.
10. A flexible tank of claim 1, with an internal baffle sheet secured between opposed tank walls, an array of apertures in the sheet, allowing restricted movement of liquid through and past the sheet, the upper surface of the tank being tethered against rising, by the dead weight of liquid acting on the floor of the tank.

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