Rock Groyne Workshop
National Oceanography Centre, Southampton
5th January 2010

Minutes from meeting

AGENDA

09:30 Registration

10:00 Basic principles of rock groyne design - *Andy Bradbury*

10:30 Rock groyne schemes in the Eastern Solent – *Matt Hosey*

11:00 From timber to rock: Rock groynes in Poole Bay – *Dave Robson*

11:30 Conventional design versus low cost structures- *Andy Bradbury*

12:00 Round the room discussions / short presentations / questions from participants

13:00 Lunch

ATTENDEES

Andy Bradbury	*Matt Hosey*	*Dave Robson*
Sam Cope	Tim Kermode	Uwe Dornbusch
Dave Picksley	Chris Moulton	Marc Bryan
Mark Stratton	Andrew Colenutt	Alun Brown
Tom Mortlock	Bernadine Maguire	Alan Gibson
Travis Mason	Cesar Azevedo	Andre Lanyon
Jim Moon	Steve Woolard	Dave Harlow
Joey O'Connor	Martyn Cooper	Kevin Rodda
Bob Kinnear	Simon Hills	Geoff Turnball
Sally Hawkins	Neil Watson	Mike Goater
Charlotte Millerchip	John Buttivant	
Peter Ferguson	Uwe Dornbusch	

INTRODUCTION

Professor Andy Bradbury (Chairman of the Southern Coastal Group) introduced the workshop, explaining that it was the second in a series of "A Problem Shared," hosted by SCOPAC and the Southern Coastal Group. He explained that the morning would cover the construction, design, management, problems and maintenance of rock groyne beach control structures and that the workshop was intended to share best practice knowledge with those new to the field.

PRESENTATION 1 - "The basic principles of rock groyne design" by Professor Andy Bradbury from the New Forest District Council

The following summarises the key aspects of the talk. Please see the slides for more detail.

SLIDE	NOTES
2	Economically, a control structure should achieve an equitable balance between capital and maintenance costs.
	In addition they should reduce longshore transport to an acceptable rate.
3	It is only with Integrated Coastal Zone Management (ICZM) that we can better address concerns of beach control structures with regard to impacts of sediment transport. ICZM promotes a more "neighbourly" approach, in this respect.
	It is important to ensure a smooth transition between protected and natural stretches of coastline
6	Picture is of Suffolk coast; rock groynes promote change to beach planshape; note cuspate form of bays.
	There are no simple "out-of-the-book" answers; a lot of design is based on empirical experimentation and accrued experience.
8	One disadvantage of rock groynes is that rip currents are often formed down the sides of groynes. This is not good from a recreation and stability viewpoint.
	However, rock structures do not suffer from the one-side overloading pressure of sediment weight, as do timber groynes.
9	Groyne efficiency is a function of groyne height above beach height. An efficient groyne would be one where little material is able to pass over the groyne top.
13	On the central English Channel Coast, engineers are typically trying to build groynes out as far as possible.
14	The addition of a groyne head extension suggests that designers aren't happy with existing groyne performance.
	Little sophistication in design of groyne head extensions (perhaps *some* physical modelling).
15	Timber groynes tend to promote scour, leading to undermining of structure (see image; undermining leads to 100% structure permeability – ineffective beach retention). Timber groynes tend to be useless if they are undermined whereas rock groynes can adjust to changing bed levels.

16	Rock groynes, however, are self-healing in this aspect i.e. if there is undermining, the rock will sink down and plug the void (although it will become less effective at the top).
	It is straightforward to build *large* rock structures (not so easy to scale-up timber groyne structures).
	Easy to modify shape of rock groyne structures.
17	The CERC equation is based on only a few hours of calibration of monitored data from Californian beaches, from the US Army Corps of Engineers. This formula is widely-used but poorly-calibrated.
	In the UK, there are a handful of different numerical models available for planshape modelling of control structures, one of which is BeachPlan (schematics SLIDE 21).
18	Groyne efficiency (i.e. permeability, flow through of groyne), as an input factor for numerical modelling, is poorly calibrated and often a “fiddle-factor”. Needs calibration through empirical measurements.
	Ideally, you should be using +10 years of monitored wave data for realistic model results.
	Modelled data is not a solution to the problem. Numerical models are just a tool.
	Make the model as simple as possible.
19	Numerical models work on the basis of *mass continuity* (what goes in, comes out).
21	Ideally, you want to promote a smooth drift rate along the beach with the introduction of groyne control structures; not areas of large scale erosion and accretion.
	During model runs it is best to input one structure at a time, and then vary its design and the conditions accordingly. This can then be taken forward to look at a groyne field. However models are not yet capable of differentiating between rock and timber groynes.
31	Highcliffe frontage comprises a mixture of long and stub groynes. Modelling was driven by two time series of wave data (see refraction points).
35	It is tricky to set up numerical models; not efficient to do unless you are doing it a lot. Usually it is more efficient to employ a specialist (consultant).
	It is often useful to make simple mathematical calculations for new structures *first* before going into numerical modelling.
57	Rock armour stability; typically designed for “no damage” scenario.
61	The longer the wave period, the larger the rock needed. However, sometimes you are restricted by size of rock you can source. So you can approach the problem by saying with a 2.5T rock size, for example, how much damage can I expect?
	In many areas, there are control structures with rock armour bigger than needed, due to poor guidance.
	Rock size needed is approximately the cube of the Hs.
63	But it is not just rock size, it is *density* as well. Portland rock is around 2.5sg, whereas Norwegian granite and Mendip limestone is denser. If you can source dense rock, you can build structures with smaller size rock armour and gain same stability.
64	Cubic rock gives more stability than rounded material.
75	Delivery method depends on size of project e.g. 20,000T of rock can be delivered in one go by barge. By sea is also more attractive to the public, rather than 450 lorries passing through their village.

78	Payment by *weight* rather than payment by *density* has proved to be more equitable.
83	Try not to build using floating plant, it can almost double the cost of the project.

The following summarises the question and answer session following the talk.

QUESTIONS / COMMENTS SESSION 1	
SPEAKER	NOTES
Dave Harlow (comment)	Rip currents can be advantageous.
	Beach replenishment should be designed with rock groynes in mind.
	Poole and Christchurch Bays are good examples of engineers trying new approaches because there was a lack of design guidance at the time (design tools weren't available in the 1970s). A lot of remaining structures are a legacy of this period.
	Is there any need to construct the shorter groynes with long ones (example of Highcliffe)? Why not just have long ones?
Steve Woolard (comment)	Groynes used to be built longer, but now through experimentation with modelling, we know we can build them shorter.
Neil Watson (question)	What are the implications of extreme events on rock groyne design?
	Can you comment on the inability of rock groynes to allow reverse drift?
Andy Bradbury (answer to Neil Watson re: implications of extreme events)	Design of groynes can allow for damage to structure
	For example, if the manual says 10-15T of rock needed, you may be able to get away with less (e.g. 3-6T)
	This way, design is cheaper and smaller BUT you should expect them to movement (implications for Health and Safety and maintenance costs)
	Therefore we have a trade-off
	Life-cycle costing suggest it is cheaper to build to allow for maintenance
	However, from a PR point-of-view, there is a reluctance to adopt this approach
Andy Bradbury (answer to Neil Watson re: drift reversal)	Structures will capture material from both directions
	Fishtail groynes are still designed for drift from a prevailing direction
Dave Harlow (comment on drift reversal)	There is a lot of drift reversal in Poole Bay, but the material cannot reverse due to control structures
	This has presented a local problem; that groynes don't allow sediment back into the system from another direction
Uwe Dornbusch (comment)	We should be thinking, as designers, when do I want my structure to work?

	A groyne, unlike a revetment, doesn't need to work that well during a storm.

PRESENTATION 2 - "Rock groyne schemes in the Eastern Solent" by Matt Hosey, Havant, Portsmouth and Gosport Group

The following summarises the key aspects of the talk. Please see the slides for more detail.

SLIDE	NOTES
3	Post-war Eastoke development was just beginning.
4	Present-day, high population density, timber groyne construction, active beach management.
5	1920s-30s flat beach profile.
6	Mid-1940s timber beach structures built.
7	In the 1970s, seawall constructed (it failed, caused scour and undermining).
8	In 1978 an apron was built to stop undermining.
9	In 1985 Very low beach levels – down to clay line in places.
10	Low beach level meant it was prone to flooding. A large beach nourishment scheme was implemented in an attempt of reduce the chances of overtopping.
13	Beach nourishment is now the primary defence to prevent overtopping. A regular beach management programme is now in place. Recycled material is taken from the west and east of Hayling Island (as there is a drift divide in the middle). Recycling is topped up with beach nourishment.
16	Construction is still to be carried out at Eastoke Point, as there is a nature reserve that backs the beach which is prone to flooding (SLIDE 17).
18	It is a volatile area (large beach line movement).
25	If you can make the contractor's job easier, the project will often turn out cheaper (e.g. design scheme to allow for land-based construction). Also calculate the footprint of the structure accurately and consider the future maintenance issues.
26	In the current structure, fines were washing out and reducing structural stability.
30	Don't force timing on contractors because any risk will be factored into price (e.g. doing a project in winter and specifying sea delivery – see photo).
32	Some quarries are now huge and have stockpiles of other sizes of rock; best to speak to sub-contractor at quarry, instead of rejecting rock on site. Testing results (to check against contract specs / CIRIA Rock Manual specs) often supplied at source.
34	Having a larger block size has meant that a steeper gradient was possible so less of a footprint and also easier to maintain.
36	At Eastoke Point, the scheme design (and modelling) is difficult because of complex sediment transport scenario (drift divide, wide beach profile envelope).

The following summarises the question and answer session following the talk.

QUESTIONS / COMMENTS SESSION 2	
SPEAKER	NOTES
Mike Goater (question)	Was the geotextile layer difficult to install and was it worthwhile installing one?
Matt Hosey (answer to Mike Goater)	The seawall had been undermined in the past and fines were being drawn out.
	The geotextile aims to stop the removal of fines.
	The geotextile went through the toe of the rock groyne and to the back of the structure.
	It was worthwhile in the sense that it hasn't yet failed! So yes.
	However, I would recommend trying to avoid the use of geotextiles because they are very fiddly for the contractor especially if you are working at or below the waterline (trying to lay the geotextile flat, and in place is hard).
Mark Stratton (question)	What is the aim of the revetment at Old Portsmouth?
Matt Hosey (answer to Mark Stratton)	The aim is to bolster the existing defences and to dissipate wave energy before it hits the seawall.

PRESENTATION 3 - "From timber to rock: rock groynes in Poole Bay" by Dave Robson, Local Engineer, Poole Borough Council

The following summarises the key aspects of the talk. Please see the slides for more detail.

SLIDE	NOTES
2	It is critical to maintain Sandbanks spit as a protection for Poole Harbour.
5	Eroding cliffs are a sediment source feeding beach.
6	1930s – seawall / timber groynes.
	1950s – rock groynes still working. Concrete cap put on.
	1990s – groynes with rock fill and timber sides (by 1994 in bad state – very low profile).
7	HR Wallingford looked at coastal protection options.
	Option selected – rock groynes to maintain a wide beach (amenity value), and also construction easier; can be built below the low water line.
9	Eastern end: Deep water channel was moving onshore, promoting erosion.
	Rock groynes needed to promote accretion and keep the channel offshore.
11	At the western end (Sandbanks peninsular); walkways were built on top of groynes.
	Busy amenity beach; makes it easier and safer for access.
12	Grant aid from MAFF.
	Used Portland limestone (better looking than dark granite, and cheaper to bring in by land).
	Harbour Commissioners ruled out the use of a barge (too shallow).
13	Excavated beach, placed bedding stone, placed rock on bedding stone (provides a working platform).
14	Piles for walkway section, pile caps, walkway section, and build up groyne around walkway (finished 1996).
17	Eastern end; work started in 2000 (Sandbanks pavilion end).
	Decided to install further rock groynes.
	Feedback from public was that they liked the walkways at Sandbanks – so built more.
18	Tight, small rock (1-3T) used = less voids = safer on an amenity beach.
	At the head there was a 1 in 4 side gradient.
	At the tail there was a 1 in 2 side gradient.
21	Not allowed to do works in the summer season. Work allowed October – Easter.
23	Shore Road, Bournemouth.
25	1985 – there was a continual length of seawall from Shore Road to the Borough boundary with Bournemouth.
	By the 1990s, this needed replacement.

	2005 – replenishment of material from capital dredge of Poole Harbour shipping channel.
	Modelling at HR Wallingford again suggested rock groynes best option.
28	Groynes built 75m long, 150m apart.
	Finished in 2009.
31	Rock groynes act like bookends (see schematic). Cost-Benefit Analysis showed that rock groyne installation all along the frontage was not cost-efficient. Instead, replenishment was carried out updrift, to feed area of no rock groynes.

The following summarises the question and answer session following the talk.

QUESTIONS / COMMENTS SESSION 3	
SPEAKER	NOTES
Pete Ferguson	Did you take into account rates of settlement in your design?
Dave Robson (answer to Pete Ferguson)	We found the lowest beach survey and excavated the beach to that level
	At Branksome we went down to the clay line
	The first groynes were installed in 1996; there was not a lot of settlement seen
	No geotextiles were used; working in the intertidal zone so deemed impractical
Dave Harlow (comment)	There was a joint beach replenishment scheme between Poole and Bournemouth in 2006
	Poole replenishment stopped approx. 300m short of the borough boundary.
	By the time Bournemouth began replenishment scheme, beach levels had already been topped up by Poole replenishment.
	The first three groyne bays were filled.
	Suggests there is a 50 to 70,000m3 drift from Poole to Bournemouth
Matt Hosey (question)	Your work sequence detailed piling after rock placement; how was this achieved?
Dave Robson (answer to Matt Hosey)	Man hole rings were put in the bed rock the piles were driven down through them.
Travis Mason (question)	Are there no other examples of walkways on rock groynes in the UK?
	Is design with a walkway more expensive?
Dave Robson (answer to Travis Mason)	It is the independent structure that is unique
	£200,000 cost for the rock groyne (similar to the price of a timber groyne in fact)
	At the toe of the rock groyne the water is not deep (unlike at Poole) so access is easier
	The walkway is 2m wide; dumpers can drive down them
	Potential H and S issues with the walkway
Dave Harlow (comment on H and S issues with walkway)	Walkways do encourage walking on the groynes but they also promote exit off groyne
	People that try to swim in Poole Harbour entrance channel have been swept along Poole frontage and have used groynes as exit from water

PRESENTATION 4 - "Conventional design vs. low-cost structures" by Professor Andy Bradbury, New Forest District Council

The following summarises the key aspects of the talk. Please see the slides for more detail.

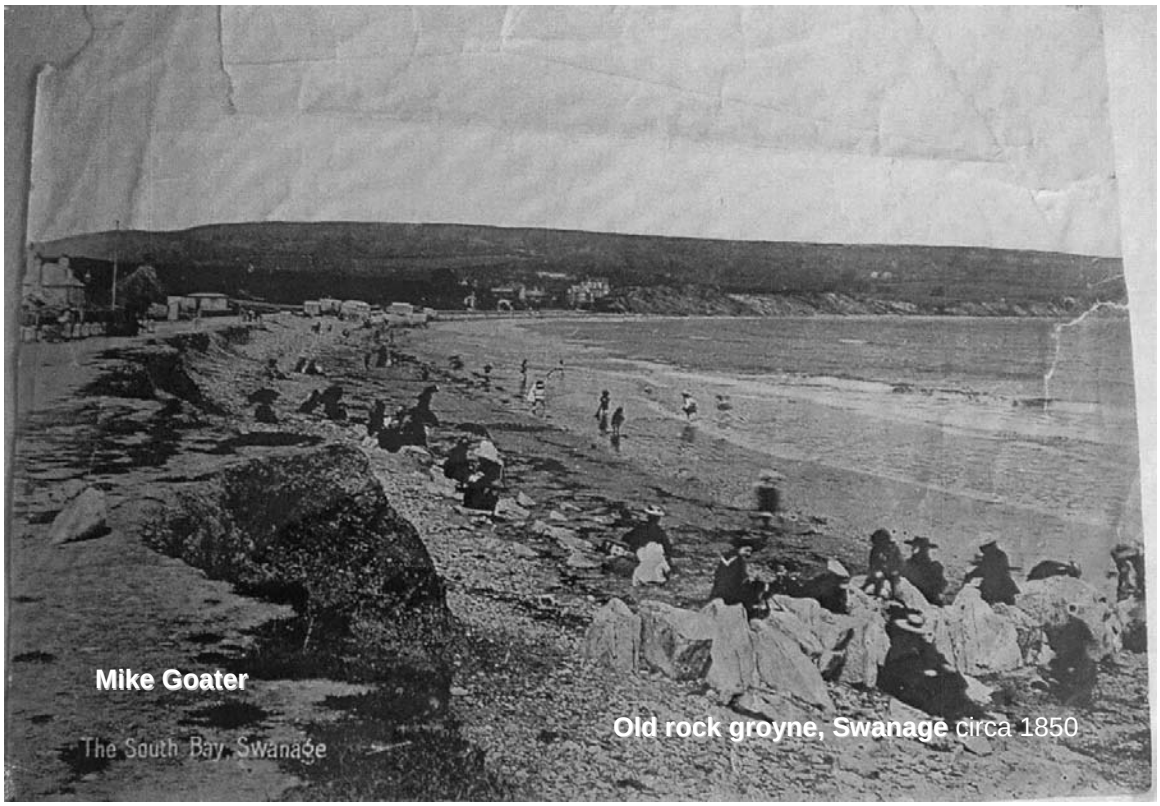
SLIDE	NOTES
86	Manuals focus on structure design which is quite expensive.
	There is often over-design (rock too big) because guidance is based on deepwater method. There is not a lot of guidance around for shallow water design.
93	At Hengisbury Head, "spine armour" had been placed on top of rock groynes (see photo) in place ready for maintenance (photo 1990, structures built 1984/1985).
104	Where the main aim is for sediment control and there is a low-risk area, then beach control structures are best designed to allow for some damage/maintenance. Where the main aim is for flood defence and there is a high-risk area, then beach control structures are best designed high capital costs – low maintenance.
108	What are the impacts of relaxing design guidance? The savings in capital costs can be used in maintenance. Usually, savings made are greater than maintenance costs needed.
110	In Christchurch Bay, material has a life expectancy of approx. ½ or 1/3 of the higher quality material suggested in the manuals.
112	When you remove geotextiles from the groyne design, you instantly lower capital costs because you increase the tidal window in which you can work.
113	Using Portland stone made a 15% saving in transport costs.
	There is a risk of criticism, however. The public perception may be that you have under-designed a structure since you need regular maintenance; so you need to adopt a good PR approach.
124	However, in today's funding regime, low cost structures are a good way of planning for life cycle maintenance.
	You can suffer a lot more damage on rock groynes than timber groynes.

QUESTIONS / COMMENTS SESSION 4	
SPEAKER	NOTES
Mike Goater (comment)	You say that Portland stone is "poor quality" but there are many different grades of this stone.
Andy Bradbury (answer to Mike Goater)	Cap stone is the best, but even this is not as good as Mendip limestone.
	Roach isn't good, neither is the building stone.
Andy Colenutt (question)	Would you recommend monitoring rock movement in rock groyne structures with laser scanning, or with photos?

Andy Bradbury (answer to Andy Colenutt)	Photos are adequate day-to-day.
	Laser scanning is a bit over the top
Neil Watson (comment)	We need to take into account the aesthetics when choosing rock type and also planning consents.
	For example, some authorities won't allow Norwegian granite.
	Also need to bear in mind the carbon footprint of importing rock.
Pete Ferguson (comment)	Purbeck stone works well in Poole Bay because the frontage has small grain size.
	Mendip better to use in Christchurch Bay because the frontage has larger grain sizes, and so is more abrasive.
Uwe Dornbusch (comment)	Modelling of design of rock groynes doesn't take into account submersion of the structure by sediment.

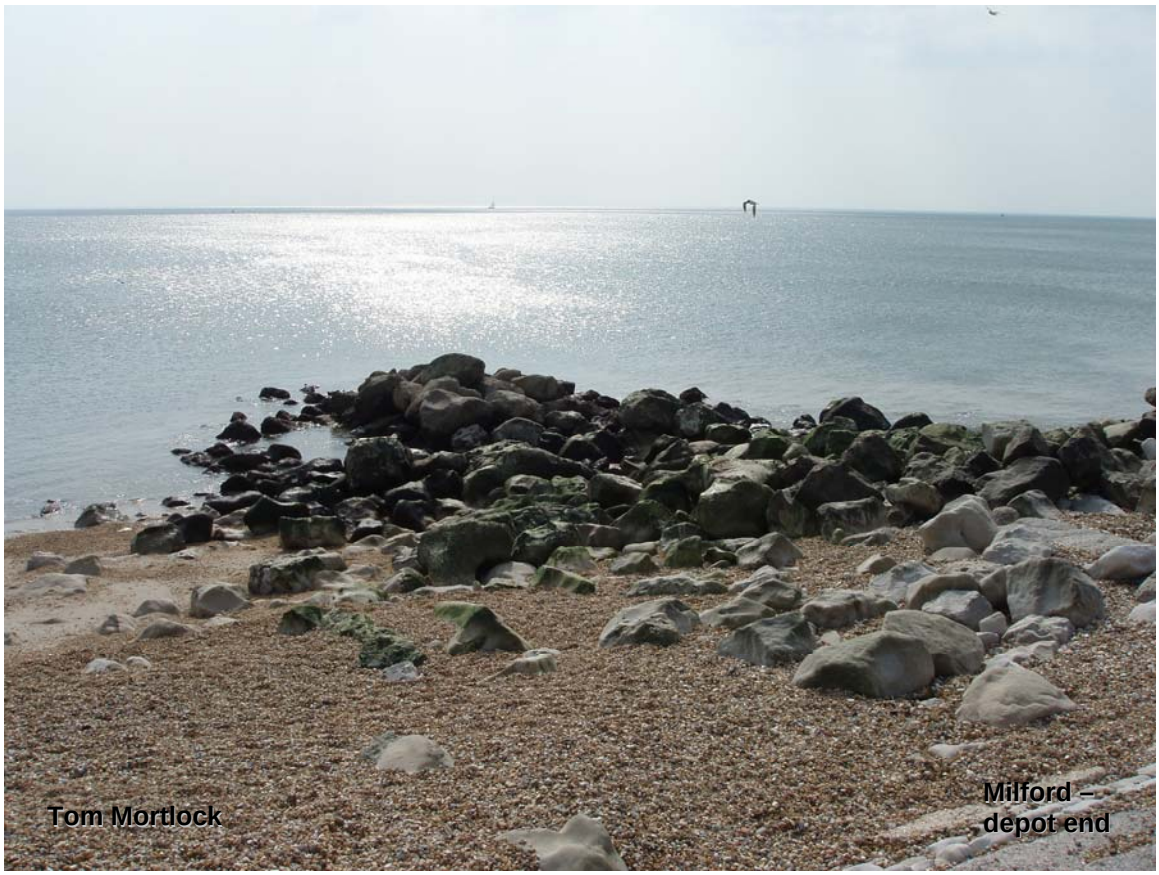
Round the room discussion

Attendees were asked to register with a photo of a rock groyne of their choice and a question or comment. The following summarises the discussion.



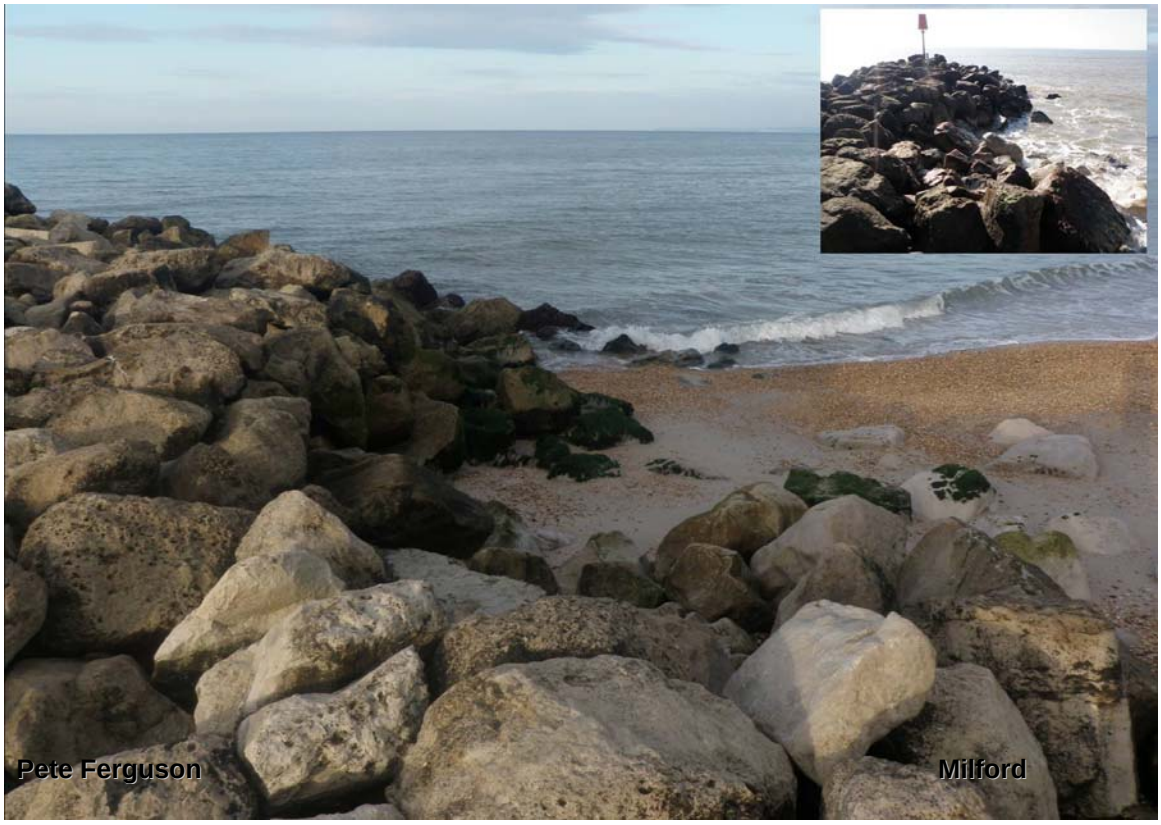
Mike Goater, Swanage Bay	Shows rock groyne in the foreground.
	Today, there are only timber groynes.
	When consulted on beach management, the public consensus was that they wanted timber groynes “like there had always been” – this image proves otherwise!

Mark Stratton, Hurst Spit breakwater	What is the over-riding driver in choosing the type of rock for groyne construction; cost or durability?
	Andy Bradbury: Firstly it is driven by the availability of the desired rock type (from a single source). Secondly the scale of the job.



Why has the groyne splayed out laterally so much since construction, and is there better design practice in place today to prevent this from happening? Also, is this a common feature in ageing rock groyne structures?

Tom Mortlock, Milford rock groyne	Groyne constructed 1983/1984.
	By early 1990s it had already splayed out.
	This was because too small rock armour was used (1-3T rather than 6T rock).
	Also the structure was too steep.



An apparent weakness in this rock strongpoint has resulted in the displacement of (approximately) 180T of rock. How should this be repaired and how can this type of damage be avoided in the future?

Pete Ferguson, Milford rock groyne	A very good example of the typical damage experienced by rock groynes in physical modelling and in the field.
	Steve Woolard: This is the kind of damage that is hard to repair as it is in a difficult area. It would need stripping right back before adding some large toe blocks to stabilize it. The work would take approximately 2 months to complete.

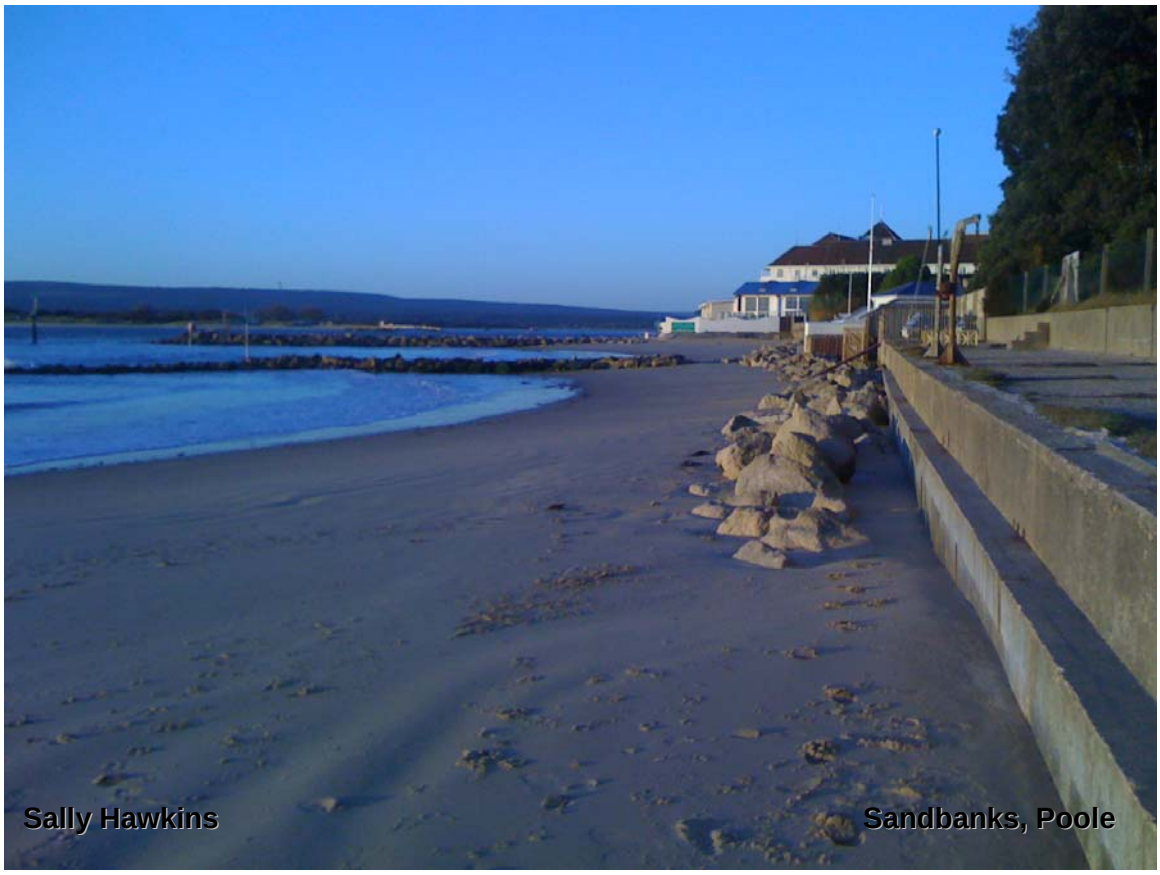
How effective are rock groynes at protecting other structures on the beach?

Charlotte Millerchip, Cowes IOW	This structure has probably been built to prevent scour of the jetty.

Are the groynes designed to encompass a given throughput of shingle - if so, how's this calculated and how does it affect the design of the groyne layout?

Has this groyne been constructed in such a way that the desired outcome is the development of a tombolo feature connecting it to the beachface?

Jim Moon, Hurst Spit terminal groyne	This structure was designed to provide a headland structure (tombolo feature).
	The problem with this is that building a tombolo will starve downdrift areas of sediment.
	If it is built further offshore, the sediment build up to the lee of the structure will be less.
	It was not built further offshore because it was prohibitively expensive.



What factors determine the position & length of these groynes & how much it would it be affected by the strong currents here?

Sally Hawkins, Sandbanks Poole	It is very difficult to model at Sandbanks. Around Harbour entrance, it is almost impossible to maintain a beach there due to strong currents flowing out of the harbour entrance.

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Uwe Dornbusch **Rottingdean**

Uwe Dornbusch	Shingle beach material moves through rock groynes depending on the beach elevation either side of the groyne. In the example the steps beneath the seawall (north west corner) have become exposed with time due to this process. Details in Dornbusch, U., 2008. Sediment transport through rock groynes on mixed beaches. *Maritime Engineering*, 161(2), pp.53-59.

Steve Woolard, Chrsitchurch Bay	Some of the rock groynes were shortened in length by around 10m
	This rock material was then used to improve other areas after storms
	Now we know we can build rock groynes shorter, we can recycle this, thereby saving material

John Buttivant, Minehead	Scheme was built in 1996 with the addition of beach re-charge. This was implemented to account for the large loss of material to the east. Is this groyne too long?

These groynes are made out of coral. Are they the correct length given small tidal range?

Dave Picksley, Maldives	The groynes are probably required for building a more substantial beach in preparation for periods of wave attack, although in general the Maldives offer a calm environment.