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THE TEN PER CENT METHOD OF PREDICTING TIDE LEVELS BETWEEN HIGH AND LOW WATER

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SUMMARY

Present methods of calculating and drawing a predicted tidal curve, although sophisticated, are cumbersome and time consuming.

The following paper describes a quick and simple method of obtaining intervening tide levels, given predicted high and low water and given a pre-computed diagram for any one station.

It is suggested that the diagram described below should be printed alongside predicted high and low waters in tide tables and/or on charts which include the appropriate tidal station.

INTRODUCTION

Harmonics are the basis of tidal theory, but certain other mathematical patterns can be derived from the shape of a tidal curve which enable a far simpler approach to be made.

If the duration of a tide from low to high water is divided into ten equal parts, an increasing percentage of the range of that tide is reached as each successive period of time passes. A pilot scheme run by the Author [1] showed that a stable arithmetic pattern does emerge, differing only in the change from spring to neap tides.

METHOD

Figure 1, which is the tidal diagram for Southend, England, is the final development of that scheme and includes certain refinements suggested by Commodore A.H. COOPER of the International Hydrographic Bureau.

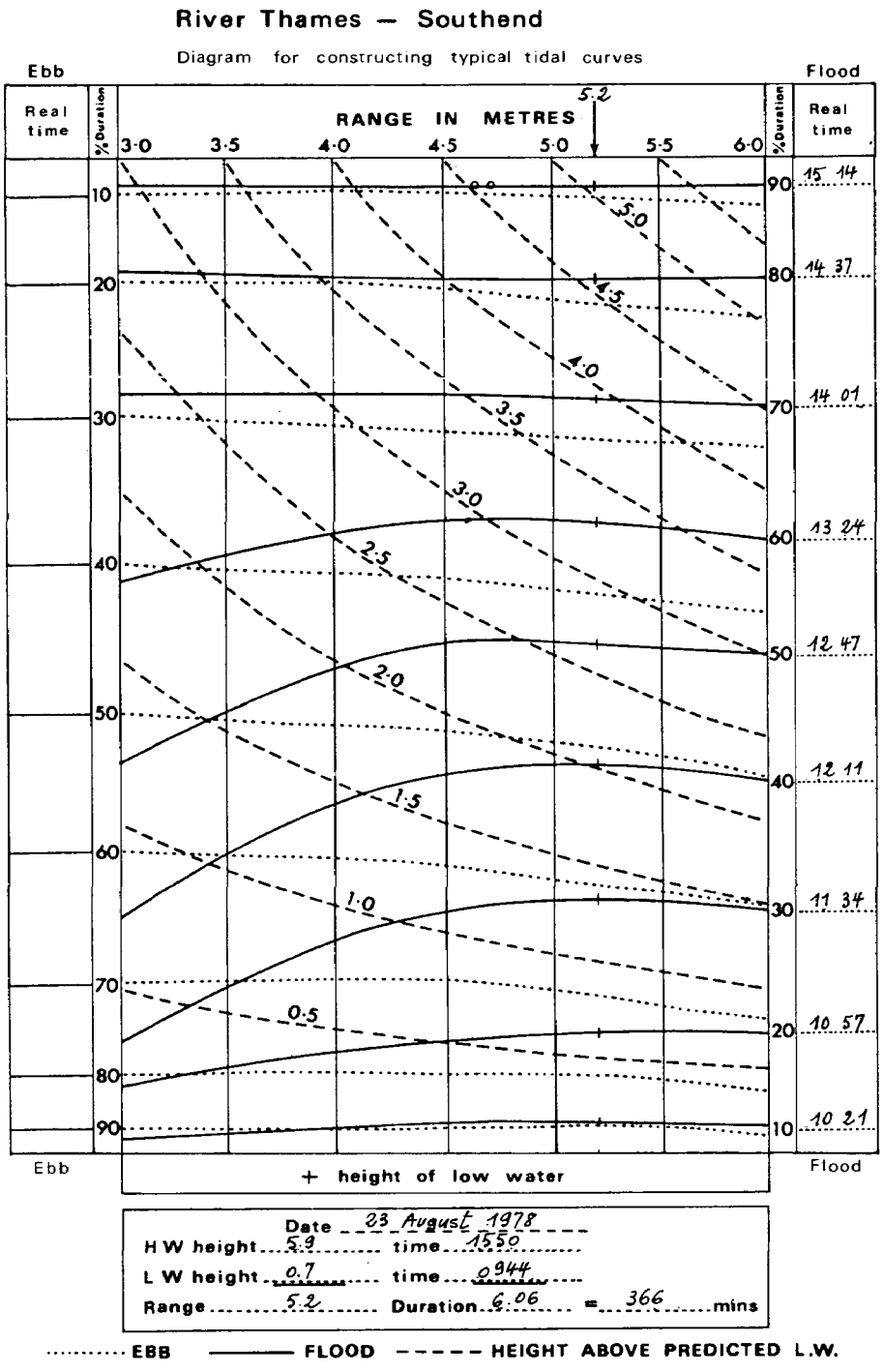
River Thames — Southend
Diagram for constructing typical tidal curves
Ebb
Flood
Real time
% Duration
RANGE IN METRES
3·0
3·5
4·0
4·5
5·0
5·5
6·0
5·2
5·0
4·5
4·0
3·5
3·0
2·5
2·0
1·5
1·0
0·5
0·0
10
20
30
40
50
60
70
80
90
15 14
14 37
14 01
13 24
12 47
12 11
11 34
10 57
10 21
+ height of low water
Date 23 August 1978
H W height 5.9 time 1550
L W height 0.7 time 0944
Range 5.2 Duration 6.06 = 366 mins
EBB
FLOOD
HEIGHT ABOVE PREDICTED L.W.

FIG. 1

In order to draw the predicted tidal curve for any day (flood or ebb) one should use the diagram in the following way.

a) Establish the predicted times and heights of high and low water from tide tables.
b) Calculate the range and duration.
c) Convert the duration to minutes, and note every 10 %.
d) Note the amount of rise shown by broken lines on the graph where each 10 % line intersects with the appropriate vertical range line (interpolating as necessary).
e) Add the height of low water to each reading.

A sample entry has been made for the flood tide of 23 August 1978, a process which took only four minutes after opening the tide tables.

The results so obtained can be plotted out, or else a mental assessment made without any plotting whatsoever. The time at which a certain tide level is reached, and conversely the height at a given time, are readily given.

It is suggested that navigators operating in much the same area over a period of days would find useful a larger scale bulkhead graph overlaid with perspex and with entries made up for each day in crayon.

Flood and ebb curves are shown on the diagram. The flood curves (shown solid) are the result of the pilot scheme previously mentioned. The ebb curves (shown dotted) are taken from a smaller number of tide examples. In a full scheme they would be derived from a computer program using the Harmonic Shallow Water Corrections method [2], each tidal station having its own diagram to match its tidal characteristics.

ADVANTAGES

The basic concept is simple. No knowledge of harmonic tidal theory is required by the user.

The time taken is short.

Calculation is so minimal that even a hand-held calculator is of little use.

The accuracy of the method is suggested by the pilot scheme to be better than 0.1 m (at Southend).

There are no problems of tying the curve to high and low water points.

A mental assessment can be made of the tidal picture without having to plot it out.

PRODUCTION OF THE DIAGRAM

So far the value to the user has been discussed, but there remains the task of the establishment of the requisite diagram for each tidal station, and this will naturally be a function of the tidal pattern at that station.

Each diagram would require the following process of construction and evaluation.

a) Calculate from known constituents (using the Harmonic Shallow Water Corrections method [2]), the continuous tidal heights over a period of at least one year in order to establish a large number of 'pure' tidal curves.
b) Sort the tides into groups consisting of similar tidal ranges.
c) Determine the height of tide at each 10 % of duration (flood and ebb).
d) Calculate average change of level at each 10 % of duration according to range grouping.
e) Construct the diagram.

The computer should also look for long term, annual or seasonal trends.

Once the diagram of a station is established it is good for all time, or until the tidal characteristics of that place change significantly.

A national Hydrographic Office, in deciding to employ this method, would follow the process above for each of its standard ports and would make the diagrams available in tide tables and on charts where those ports appear.

An individual who does not have the services of a computer but wishes to produce such a diagram may wish to follow the process used in the Author's pilot scheme [1]. In this, the actual (recorded) tidal curves which came within 0.2 m of predicted range and 5 minutes of predicted duration during one year were analysed by noting what height was reached at each 10 % of duration and constructing the diagram from those figures.

The process could be said to be a development of the method described in Table I of the Admiralty Tide Tables [3], but whereas that gives a spring and a neap curve plus assistance with interpolation, the 10 % diagram gives figures not only at many intervals in between, but also for those ranges which may occur beyond normal spring or neap levels. It also reduces the amount of calculation required, so lowering the possibility of error.

CONCLUSION

There are sufficient users of tide tables and hydrographic charts, such as civil engineers, harbourmasters, yachtsmen and coastal shipping, to warrant a system which is simple and fast.

The accuracy of 0.1 m suggested is more than sufficient when one realizes that probably over 80 % of tides are distorted away from prediction by meteorological conditions.

This 'Ten Percent' method could be made readily available to all by having the appropriate diagram included alongside the predicted high and low waters in tide tables and printed on charts whenever space allows.

Above all, the chart producer now has the opportunity to describe the complete tidal picture of a station in one single block.

ACKNOWLEDGEMENTS

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REFERENCES

[1] EKBLOM, R. (1975) : The prediction of typical tidal curves. *Hydrographic Journal*, 2 (1), Spring, pp. 27-29, London.

[2] DOODSON, A.T. (1957) : The analysis and prediction of tides in shallow water. *Int. Hydrog. Review*, XXXIV (1), pp. 85-126, Monaco.

[3] *Admiralty Tide Tables.* Table I. NP 201 (3 volumes). Hydrographer of the Navy, Taunton, UK.

OCEAN

The Sea, our sea, thou great and glorious sea,
Yield up thy secrets to our weak and fumbling band
Whose probing passion and bright eyes doth bring a joy,
[a glory,
An overwhelming magnificence to many a trifling detail
of thy vast dark deep interior's plan.
The slime, the filth, the excrement of eons becomes a
[glorious history
To those whose minds can conjure from these bare
bits, a living teeming mass of life of yesteryears,
A fiery blast of Vulcan or a cosmic comet's searing fall.
The earth's alive to all who care to read its rustic
book and ponder past and future.
But 'tis not the knowing but the learning to which
all our thoughts, ambitions and desires aspire.
For life is to live and not to hoard; our striving,
driving, living days are themselves just and due reward.
Honors, titles and epithets are but empty words, for
joy of teaching, joy of learning,
Joy at the instants of revelation are our life's real rewards.

Written by the late Dr. Bruce C. HEEZEN, and published in *The Face of the Deep*, by B.C. HEEZEN & C.D. HOLLISTER, p. 615 (Oxford University Press, New York, 1971).